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PARTIAL REPLACEMENT OF FINE AGGREGATE USING GLASS POWDER AND COURSE AGGREGATE USING CRUSHED CONCRETE IN CONCRETE BRICK

Mohammed Faisal[1], Aman Sanash[2]

[1]Department of Civil Engineering, P. A. College of Engineering, Mangaluru, Karnataka, India.

*Corresponding Author: Mohammed Faisal Email: zzzfaizy@gmail.com

ABSTRACT:

Cement concrete is one of the most commonly used materials in modern buildings. The evolution of technology and contemporary living habits has caused a surge in the production and diversity of waste, resulting in a crisis in waste management. This research addresses the issue of waste originating from construction activities, such as discarded concrete and glass. To mitigate the accumulation of specific types of waste, there is a suggestion to repurpose some of these materials by integrating them as substitutes for a portion of the primary constituents in cement concrete blocks utilized in construction endeavors. This research investigates the feasibility of partially replacing fine aggregate with glass powder and coarse aggregate with crushed concrete in the production of concrete bricks. The study focuses on replacing fine aggregate with glass powder at 10% and 20% levels, and replacing coarse aggregate with crushed concrete at 10%, 20%, and 30% levels. The compressive strength of the resulting concrete bricks was evaluated to assess the feasibility and potential benefits of these substitutions. Experimental tests were conducted to measure the compressive strength of concrete bricks with varying replacement levels of glass powder and crushed concrete. The results indicate that the partial replacement of fine aggregate with glass powder and coarse aggregate with crushed concrete does not significantly compromise the compressive strength of the concrete bricks. Furthermore, the research demonstrates that replacing fine aggregate with glass powder and coarse aggregate with crushed concrete can potentially enhance the sustainability of concrete production by utilizing waste materials.

Key Words: Concrete bricks, Fine aggregate, Glass powder, Coarse aggregate, Crushed concrete, Compressive strength, Sustainability

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1. INTRODUCTION

The construction industry is constantly seeking innovative approaches to enhance the sustainability of building materials and reduce environmental impact. Concrete, being one of the most widely used construction materials, plays a crucial role in infrastructure development worldwide [1-5]. However, the production of conventional concrete involves significant extraction of natural resources and energy consumption, contributing to environmental degradation [6-10]. To address these challenges, researchers and practitioners have been exploring alternative materials and methods to improve the sustainability of concrete production. One such approach involves the partial replacement of traditional constituents with recycled or waste materials. This not only reduces the consumption of natural resources but also mitigates the accumulation of waste in landfills [10-13].

Partial replacement of traditional aggregates with recycled or waste materials has emerged as a promising strategy to achieve these goals (Siddique & Khan, 2011) [14]. Glass powder, a byproduct of the glass industry, and crushed concrete, derived from demolition waste, are two such materials that have gained attention for their potential as supplementary cementitious materials and aggregate replacements, respectively (Tavakoli et al., 2019 [15]; Pacheco-Torgal et al., 2018 [16]). Incorporating these waste materials into concrete production not only reduces the consumption of natural resources but also diverts waste from landfills, addressing both environmental and economic concerns (Rahman & Al-Hashmi, 2017) [17].

Moreover, the study examines the environmental implications of using glass powder and crushed concrete as partial replacements for fine and coarse aggregates, respectively. By diverting waste materials from landfills and reducing the demand for virgin resources, the proposed approach has the potential to contribute to environmental conservation and sustainable development.

Overall, this research aims to provide valuable insights into the feasibility and effectiveness of incorporating waste materials into concrete production for the manufacturing of sustainable concrete bricks. The findings of this study can inform decision-making processes in the construction industry and promote the adoption of environmentally friendly practices in concrete manufacturing.

This study focuses on evaluating the feasibility of partially replacing fine aggregate with glass powder and coarse aggregate with crushed concrete in the production of concrete bricks. The compressive strength of these bricks is a critical parameter for assessing their structural

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performance and suitability for various construction applications (Neville, 2011) [18]. Understanding how different replacement levels of glass powder and crushed concrete affect compressive strength is essential for determining the practicality and viability of this sustainable approach.

Furthermore, the environmental implications of using waste materials in concrete production are a key consideration. By reducing the demand for virgin resources and minimizing waste generation, sustainable concrete production practices contribute to environmental conservation and promote circular economy principles (Tam & Tam, 2020) [19].

This research aims to provide valuable insights into the feasibility and effectiveness of incorporating glass powder and crushed concrete as partial replacements for fine and coarse aggregates, respectively, in concrete brick manufacturing. By addressing both technical and environmental aspects, the findings of this study can inform decision-making processes in the construction industry and support the adoption of sustainable practices.

2. OBJECTIVE

The major goal of this study is to examine how well cement concrete mixes function when recycled waste materials like glass and crushed concrete are included as a portion of the aggregates in cement concrete block mixtures. This will be proved by experimental laboratory testing that substitute a portion of the fine aggregates in cement concrete blocks with fine glass aggregates and a portion of the coarse aggregates with crushed concrete

The objectives of this study are,

1. To determine the ideal replacement ratio for broken concrete as the coarse aggregate and glass powder as the fine aggregate in concrete blocks

determine the effect of using calcium and urea for the formation of bio concrete.

2. To evaluate the parameters governing the strength of concrete produced using glass powder and broken concrete. Check the strength parameters of concrete made using glass powder and crushed concrete.

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3. METHODOLOGY

3.1 METHODOLOGY

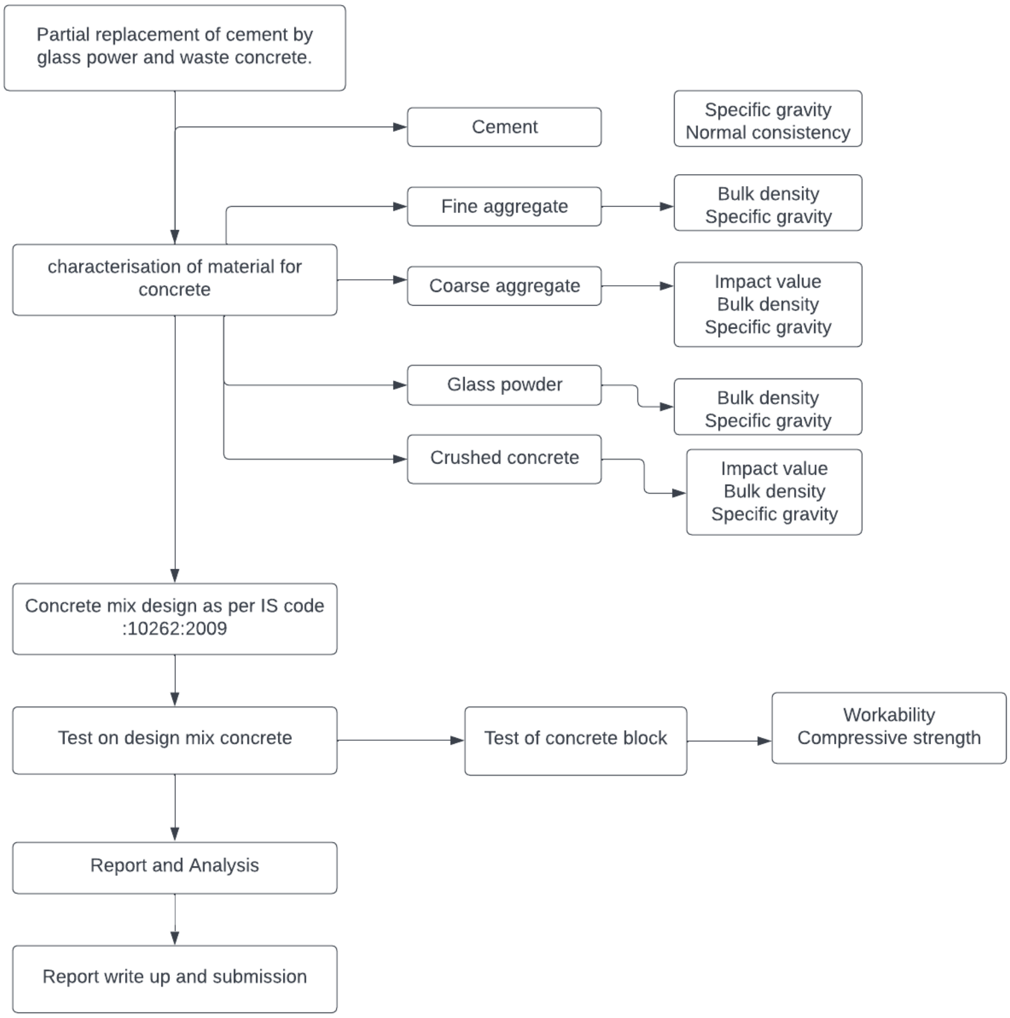

Figure 1: Methodology

3.2 MATERIALS

The physical characteristics of the following materials, which must be examined in laboratories: cement, fine aggregate, coarse aggregate, glass powder, crushed concrete, and water utilised in the mix design of concrete blocks.

3.2.1 Cement

The mentioned characteristics of the cement that was used. An adhesive that hardens and sticks to other materials to bind them together, cement is a binder, a chemical compound used in construction. In most cases, cement is used to bond sand and gravel (aggregate), not on its own.

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Concrete is created by mixing cement with sand and gravel, or with fine aggregate to create a masonry motor. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

3.2.2 Fine Aggregate

Fine aggregates are essentially any unrefined sand that has been extracted from the earth through mining. Natural sand or any broken stone fragments that are 1/4" or smaller make up fine aggregates. Due to the size, or grade, of this specific aggregate, this product is frequently referred to as 1/4 minus. Examples of fine aggregate used in concrete include sand, surki, stone screens, burnt clays, cinders, fly ash, etc. Brick chips, stone chips, gravel, pebbles, clinkers, cinders, etc. are all examples of fractured materials.

3.2.3 Coarse Aggregate

Concrete is made with coarse aggregates, which are granular and uneven materials like sand, gravel, or crushed stone. Coarse is typically found in nature and can be obtained by blasting quarries or crushing them manually or with crushers. They must be thoroughly cleaned before being used to make concrete.

3.2.4 Glass Powder

Another waste product that is produced in great amounts and is challenging to eliminate is waste glass. It is well known that the majority of waste glass, particularly container glass, is collected, remelted, and utilised to make new glass. However, not all of the used glass can be used to make new glass.

3.2.5 Crushed Concrete

Large volumes of waste are produced during the manufacture and usage of concrete in addition to garbage from old concrete. Demolished concrete, concrete sludge, concrete grinding residue (CGR), and waste concrete fine are a few different types of concrete waste.

4. RESULT AND DISCUSSIONS

4.1 Specific Gravity Test: The specific gravity (G)of a material is the ratio of the mass of a unit volume of soil solids at a specific temperature to the mass of an equal volume of gas-free distilled water at the same temperature.

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Specific gravity test for fine sand and glass powder was done. Specific Gravity of fine sand was obtained 2.6 and Specific Gravity of glass powder was obtained 2.6.

Specific Gravity of coarse aggregate was obtained 2.7. Specific Gravity of concrete waste was obtained 2.7.

Table 1: Specific Gravity Test

	Fine sand	Glass powder	Coarse aggregate	Concrete waste
Specific gravity	2.6	2.6	2.7	2.7

4.2 Selection of Concrete Block Grade

Minimum strength of brick for Load Bearing wall- 3.5 N/mm2. Design strength chosen for the project- 5N/mm2 We choose respective mix ratio of materials for specified concrete strength. ie; Cement: Sand: Coarse Aggregate = 1:5:10, which is the Mix Design for M5 concrete.

Table 2: Is Class Designation of Brick

Classification of bricks based on IS 1077:1992	
Classes of burnt clay bricks	
Class deisignation	Average compressive strength not less than (N/mm2)
35	35
30	30
25	25
20	20
17.5	17.5
15	15
12.5	12.5
10	10
7.5	7.5
5	5
3.5	3.5

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4.3. Ratio of Glass Powder and Concrete Waste

Table 3: Ratio of Mix

Glass powder %	Concrete waste %
Glass powder 10%	Concrete waste 10%
	Concrete waste 20%
	Concrete waste 30%
Glass powder 20%	Concrete waste 10%
	Concrete waste 20%
	Concrete waste 30%

4.4 Compressive Strength Result

The compressive loads and strengths at which the different cubes failed were as shown in the tables. The value of compressive strength of each of the specimen cubes is given by the expression below;

Compressive strength = $\frac{Maximum\ compressive\ load}{Cross - sectional\ area\ of\ specimen}$

Where,

$Compressive\ strength$ =$Maximum\ compressive\ load$

$Cross - sectional\ area\ of\ specimen$

In this case the standard moulds of 15cm were used giving cubes whose area was;

$Area$ = 15x15 = 225cm2 (22500mm2)

Test were conducted after 14 days of casting. Minimum Compressive strength after 14 days is 90%. That is, 4.5 KN/mm2 after 14 days for M5 concrete.

Table 4: Compressive Strength Gain Chart

Recommended result of cube test	
Age of concrete	Minimum compressive strength of concrete (%)
1 day	16%

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3 days	40%
7 days	65%
14 days	90%
28 days	99%

Table 5: Compressive Strength Test Result

Glass Replacement (%)	**Crushed Concrete Replacement (%)**	**Maximum Loads (KN)**			**Compressive strength (N/mm2)**			**Average Compressive Strength (N/mm2) (After 14 Days)**
		Sample 1	**Sample 2**	**Sample 3**	**Sample 1**	**Sample 2**	**Sample 3**	
10	**10**	**135**	**140**	**130**	**6**	**6.22**	**5.77**	**5.99**
10	**20**	**130**	**125**	**120**	**5.77**	**5.55**	**5.33**	**5.55**
10	**30**	**125**	**115**	**105**	**5.55**	**5.11**	**4.66**	**5.10**
20	**10**	**140**	**130**	**120**	**6.22**	**5.77**	**5.33**	**5.77**
20	**20**	**130**	**120**	**110**	**5.77**	**5.33**	**4.88**	**5.33**
20	**30**	**115**	**105**	**110**	**5.11**	**4.66**	**4.88**	**4.88**

From the results in the table above, it was observed that there was a general decrease in compressive strength with increase in glass powder percentage and increase in crushed concrete percentage. This is due to the fact that natural fine and coarse aggregates have a higher crushing value than glass powder and crushed concrete. This has an overall effect of decreasing strength of concrete

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4.5 Results and Discussion

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5. CONCLUSION AND RECOMMENDATION

It was generally observed that the compressive strength decreased with increase in glass powder and crushed concrete replacement. Considering the compressive strength of the cubes after 14 days of curing, it can be observed that at 30% replacement of fine aggregate with glass powder and 30% replacement of coarse aggregate with crushed concrete, the value of compressive strength was higher than the expected design 5KN/mm2. Conclusively, a glass powder replacement between 0 - 30% and crushed concrete replacement between 0 - 30% will give the required strength

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