

Development of Eco-Friendly Brick by Using Glass Powder

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Abstract: *The construction industry is witnessing a growing demand for sustainable building materials to mitigate environmental impact. This study focuses on the development of ecofriendly fly ash bricks by incorporating glass powder as a replacement for stone dust. The research explores the feasibility of utilizing glass powder, a by-product of the glass industry, as a supplementary material in fly ash brick manufacturing. Various mix proportions of fly ash, cement, stone dust, and glass powder are investigated to determine the optimal composition for producing bricks with enhanced mechanical properties. Experimental results reveal the potential of glass powder in enhancing the compressive strength, durability, and thermal insulation properties of fly ash bricks. The developed eco-friendly fly ash bricks offer a sustainable solution for the construction industry, contributing to waste minimization and environmental conservation. This research contributes to the advancement of green building materials, fostering a more sustainable built environment.*

Keywords: *Soda Lime Glass Powder, Fly Ash, Stone Dust, Cement.*

1. INTRODUCTION

In today's rapidly evolving world, sustainability has become a paramount concern in all facets of human activity, especially in the construction industry. With the growing awareness of environmental degradation and the pressing need to mitigate its impact, innovative approaches are essential. One such breakthrough is the development of eco-friendly fly ash bricks enriched with glass powder.

Fly ash, a byproduct of coal combustion, has long been utilized in construction due to its abundance and binding properties. However, its environmental footprint has raised concerns. In response, researchers have turned to incorporating glass powder, a recycled material, to enhance the sustainability of fly ash bricks. This introduction presents a glimpse into the development of eco-friendly fly ash bricks fortified with glass powder, outlining the rationale, benefits, and potential implications of this innovative construction material. Through meticulous research and experimentation, engineers and scientists have endeavoured to create a product that not only meets structural requirements but also aligns with environmental stewardship principles. The fusion of fly ash and glass powder offers a myriad of advantages, including reduced carbon emissions, enhanced durability, and decreased reliance on traditional clay bricks. Moreover, by diverting glass waste from landfill and incorporating it into construction materials, this approach contributes to the circular economy paradigm, fostering resource efficiency and waste reduction.

As we delve deeper into the realm of sustainable construction, the development of eco-friendly fly ash bricks utilizing glass powder emerges as a beacon of hope, signalling a shift towards greener, more responsible building practices. Through collaborative efforts between academia,

industry, and policymakers, this innovation holds the potential to revolutionize the construction landscape, paving the way for a more sustainable future.

In the subsequent sections, we will explore the manufacturing process, properties, and applications of these eco-friendly bricks, shedding light on their transformative impact on the construction industry and the environment at large.

2. MATERIALS AND METHODS

Fly Ash

Fly ash typically consists of fine particles ranging in size from less than 1 micron to over 100 microns. Fly ash contains various oxides such as silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3), calcium oxide (CaO), and magnesium oxide (MgO), among others. The composition can vary significantly depending on the source. Fly ash can vary in colour from light grey to dark grey, depending on its composition and source. Fly ash is generally porous, which can affect its water absorption and permeability characteristics when used in construction materials. Fly ash can enhance the strength and durability of the resulting material due to its pozzolanic properties.

Glass Powder



It is transparent or translucent, allowing light to pass through. It is relatively hard, but not as hard as some other types of glass. Soda lime Glass powder obtained from a dumping yard. Those glass powders passing less than 1.18 mm are used for the production of brick.

2.1 Stone Dust

Locally available stone dust passing through IS 1.18 mm was used in this study containing 40% of stone dust is used.

Constituents	Fly ash Percentage	Stone Dust	Soda lime Glass powder %
SiO_2	48.09	65.73	78.78
Al_2O_3	23.2	19.31	1.23
Fe_2O_3	11	5.27	0.78
SO_3	-	-	-
CaO	-	3.64	6.56
MgO	-	2.16	1.63
Na_2O	-	-	12.15
K_2O	-	2.26	1.95

2.2 Cement

OPC (Ordinary Portland Cement) 53 grade is a type of cement that is widely used in construction due to its high compressive strength and durability. Here are some key properties:

Compressive Strength: OPC 53 grade cement typically has a minimum compressive strength of 53 MPa.

(Megapascals) after 28 days of curing. This makes it suitable for structures where high strength is required.

Setting Time: It has a relatively fast setting time, which means it starts to harden and gain strength quickly after mixing with water.

Durability: OPC 53 grade cement offers good durability, making it suitable for structures exposed to harsh environmental conditions.

Chemical Composition: It primarily consists of calcium, silicon, aluminium, and iron compounds. The proportions of these compounds influence its properties.

Fineness: The fineness of OPC 53 grade cement affects its hydration rate and strength development. Finer particles typically lead to faster setting and higher early strength.

Heat of Hydration: OPC 53 grade cement generates heat during hydration, which can be advantageous in cold weather but may require precautions in hot weather to control the temperature rise.

3. MIX PROPORTION

This study consists of five different mixtures for two types of bricks were prepared and casted. The dimension of the non-modular brick are chosen according to the Indian Standard (IS12894:2002)-230mmX110mmX70mm. In the first type only fly ash was used to prepare the brick. In the second type, stone dust is partially replaced with Soda-Lime glass powder for the preparation of brick.

Throughout the project, the glass powders (Soda lime glass powder) is replaced instead with various percentage i.e. 5%, 10%, 15%, 20%, and 25%.

4. BRICK PRODUCTION

The production of fly ash Brick containing replacement of soda lime powder in manufacturing of Bricks. The production of the brick was done in brick plant by using High Pressure Hydraulic Machine.



The Production stage for the preparation of the block as follows.

1. Mixing the Raw Material-Mix the Fly Ash, Glass Powder, Stone Dust, is manually fed into

- a pan mixer according to the controlled proportion. Some amount of water to the mixer for the initiate the mixing.
2. Allow the mixture to pass through the conveyor to transfer raw material from mixer to feeding hopper hydraulic press.
 3. The corresponding mixture is over fill the mould cavity containing the dimension of 230mmx110mmx70mm.
 4. After Pressing, the Bricks are demolded & the Pallet with Bricks is pushed out of the Press. After that the Pallet is stacked to the stacking area.
 5. The Bricks are air dried for 24 hours until it gets hard.
 6. The prepared bricks are cured for 7 days and 14 days and dried in regular temperature. The curing of bricks is done by covering it with Gunny Bags. The moisture in the gunny bag is maintained regularly for the better curing.

5. TEST METHOD

A series of test are done according to IS 3495:1992-Methods of testing of burnt clay building bricks. The glass powders at the respective rate of 5%, 10%, 15%, 20%, 25% replacement in fly ash bricks with the dimension of 230mmx110mmx70mm are used to find the compressive strength of brick, water absorption, efflorescence test Soundness test. Compressive strength for 7 days Dimension=230mm x 110mm x 70mm

6. RESULTS AND DISCUSSION

Compressive Strength Test of 7 Days Dimension: - 230mm x 110mm x 70mm

The tested results of the samples containing stone dust Soda lime glass powders at the respective rate of 5%, 10%, 15%, 20%, 25% with the dimension of brick 230x110x70mm. The compressive strength of the brick is done to find the amount of stress that the brick can withstand their respective area cross section by using the universal testing machine

The table No. 6.1 & 6.2 shows the result Compressive.

strength of Soda Lime glass Powder in fly ash bricks. The results of stone dust replaced 20% Soda lime glass powder containing bricks compressive strength are in 3.08 N/mm², 4.34N/mm² of 7th day and 14th day strength. The maximum compressive strength was attained in replacement of 20% Soda lime glass powder in fly ash containing bricks shows the feasible compressive strength. Thus, the Glass powder particles have the inherent capacity to increase the strength to the bricks.

Conducting rigorous testing to assess the strength and durability of the bricks compared to traditional fly ash bricks.

Analysing the overall environmental impact, including energy savings, and waste diversion from landfills.

Promoting awareness among consumers, builders, and policymakers about the benefits of using eco-friendly construction materials and incentivizing their adoption through green building certifications or incentives.

6.1 Compressive strength for 7 days Dimension =230mm x 110mm x 70mm

Samples	Dimension of Brick Length and Brick (In	Surface Area of Brick	Total Load in Kilonewton	Load in Newton	Load in N/mm ²	Prescribe Limit in
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	mm)	(L x B) in mm ²				N/mm ²
0%	230 x 110	25300	130	130000	5.13	10
5%	230 x 110	25300	140	140000	5.53	10
10%	230 x 110	25300	84	84000	3.32	10
15%	230 x 110	25300	76	76000	3.00	10
20%	230 x 110	25300	78	78000	3.08	10
25%	230 x 110	25300	104	104000	4.11	10

6.2 Comp

Samples	Dimension of Brick Length and Brick (In mm)	Surface Area of brick (L x B) In mm ²	Total Load In Kilonewton	Load In Newton	Load in N/mm ²	Prescribe Limit In N/mm ²
0%	230 x 110	25300	158	158000	6.24	10
5%	230 x 110	25300	98	98000	3.87	10
10%	230 x 110	25300	92	92000	3.63	10
15%	230 x 110	25300	102	102000	4.03	10
20%	230 x 110	25300	110	110000	4.34	10
25%	230 x 110	25300	102	102000	4.03	10

7. WATER ABSORPTION TEST

Water absorption test of fly ash brick the water absorption test for fly ash bricks is conducted to determine the porosity and permeability of the bricks. Here's how it's typically done:

Sample Preparation: Select a representative sample of fly ash bricks.

Initial Weight Measurement: Weigh each dry brick individually and record the weights.

Immersion: Immerse the dry bricks completely in water at room temperature for a specified duration, usually 24 hours.

Final Weight Measurement: After the soaking period, remove the bricks from the water, allow excess water to drain, and weigh each brick again.

Calculation: Calculate the water absorption percentage using the formula:

$$\text{Water Absorption (\%)} = \frac{(\text{Weight after soaking} - \text{Initial weight})}{\text{Initial weight}} \times 100$$

This test helps in assessing the quality of fly ash bricks by determining their ability to absorb water, which is crucial for evaluating their durability and resistance to weathering.

7.1 Water Absorption Test of Bricks

Samples	Weight of Brick in gm A	Weight of Brick (SSD) in gm B	Weight of water in gm C C=B-A	% of water absorption in gm D D=C/A x 100	Acceptable Limit
0	2526	2808	282	11.16	
5	2369	2729	360	15.19	less than

10	2582	2864	282	10.92	20% as per
15	2967	3253	286	9.63	IS 12894:
20	2843	3158	315	11.07	2002
25	2708	3031	323	11.92	

The soda lime replaced samples are tested values for water absorption test as shown in the table No.7.1 the result shows the water absorption rate of 9.63% for a 15% replaced soda lime powder in the bricks. The water absorption result shows the greater possibility of water penetrating capabilities are reduced and its efficiency in building plays a great role in the building as compared to the conventional fly ash brick. The respective values provoke the low water absorption rate as stated in IS 12894:2002 code of fly ash bricks in accordance of not more than 20% of mass.

8. CONCLUSION

The utilization of soda lime glass powder in the production of ecofriendly fly ash bricks presents a promising avenue for sustainable construction practices. By incorporating this waste material into the brick-making process, it not only reduces the environmental burden of glass disposal but also enhances the strength and durability of the bricks. Additionally, the use of eco-friendly materials aligns with global efforts towards reducing carbon footprint and promoting circular economy principles. Embracing such innovative approaches in construction can pave the way for greener and more sustainable building practices in the future.

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