Experimental Investigation of Interlocking Bricks with Partial Replacement of Cement with Recycled Glass Powder and Fly Ash

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ABSTRACT - This report outlines the utilization of recycled glass powder (RGP) in construction industries. The bricks were manufactured by mixing fly ash, recycled glass powder, cement, sand and then moulded into interlocking shapes. The physical, mechanical properties and durability of the bricks were evaluate through various tests, including Compressive Strength, Water Absorption. The use of fly ash and recycled glass powder also demonstrated significant environmental benefits, including reduced greenhouse gas emission and waste utilization. The combination of cement bricks with different percentages of the recycled glass powder and fly ash with 5%,10%,15%,20% has been added. The outcome of this study suggest that inter locking bricks made from fly ash and recycled glass powder can be a viable alternative traditional brick, offering improved sustainability, reduced environmental impact and enhanced performance. Utilizing recycled glass powder as construction materials especially production of bricks is one of a promising step towards a sustainable resource and waste management.

Key words: Recycled Glass Powder, Fly Ash, Fine Aggregate, Cement.

I. INTRODUCTION

1.1 Interlocking bricks

Interlocking bricks are innovative and eco-friendly construction material designed to provide an alternative to conventional bricks. They are made from a mixture of sand, cement, and soil, or sometimes using industrial waste products like fly ash. The design of these bricks includes grooves and projections that enable them to lock together securely, eliminating or significantly reducing the need for mortar during construction.

Introduced as a cost-effective and sustainable solution, interlocking bricks are widely used in residential, commercial, and infrastructural projects, particularly in areas where traditional materials and methods are expensive or impractical. They are known for their strength, durability, and ease of use, making them a popular choice for modern construction techniques.

II. METHODOLOGY

- Finding out the Properties of Materials.
- Batching of Materials.
- Preparation of Mix Design.
- Mixing of Materials.
- Moulding and Casting of Interlocking Bricks.
- Testing of Specimens

III. MATERIALS USED

Materials used for the casting and investigation are listed below:

3.1 Cement: Ordinary Portland cement of 53 grade conforming to IS: 169-1989 has been used for this investigation. The result of tests included on cement are as follow.

Picture 3.1- CEMENT

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Table 3.1- Properties of Cement

S.no	Property	Required as per IS 1489-1	VALUE
1.	Fineness	<10%	9%
2.	Specific gravity	3.1-3.16	3.14
3.	Initial setting time	30MINS	30MINS
4.	Final setting time	<600MINS	580MINS

3.2 Fly ash: Fly ash is a fine, powdery byproduct of burning pulverized coal in thermal power plants. It is primarily composed of silica, alumina, and iron oxides, making it a valuable material in various industries, particularly in construction. When coal is burned to generate electricity, the non-combustible minerals present in the coal fuse and solidify into small particles, which are then carried away by flue gases. Electrostatic precipitators or bag filters capture these particles, resulting in fly ash. The composition of fly ash varies depending on the type of coal used but generally contains silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3), and calcium oxide (CaO).

Fly Ash obtained from steel plant has been tested for the properties and has been used for this investigation.

Picture 3.2- Fly ash

Table 3.2- Properties of Fly Ash as replacement for binding material

S.no	Property	VALUE
1.	Fineness	9.1%
2.	Specific gravity	2.97

3.3 RECYCLED GLASS POWDER:

Recycled glass powder is a finely ground material made from waste glass that has been processed and repurposed for various industrial applications. It is an eco-friendly alternative to traditional raw materials, contributing to sustainability by reducing glass waste in landfills. sustainable material with diverse applications in construction, manufacturing, and environmental conservation. Its use helps reduce waste, lower carbon footprints, and promote circular economy practices. Glass bottles like cool drink bottles, water bottles etc. from different areas has been collected and grated into powder form and has been utilized for this investigation

Picture 3.3- Glass Powder

Table 3.3- Properties of Glass Powder as replacement for binding material

.no	Property	VALUE
1.	Fineness	7.6%
2.	Specific gravity	2.71

FINE AGGREGATE: Fine aggregate plays a vital role in construction by ensuring the strength, stability, and durability of structures. The choice between natural and artificial aggregates depends on availability, quality, and environmental. Fine aggregate is a crucial component in construction materials, consisting of small, granular particles that pass through a

4.75 mm sieve. It is primarily used in concrete, mortar, and plaster to fill voids between coarse aggregates, improve workability, and enhance the strength of construction material considerations. Natural river sand was used as a fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-1). The results are shown in test data of materials. The results obtained from sieve analysis are furnished. The results indicate that the sand conforms to zone 11 of IS: 383-1970.

Picture 3.4:- Fine Aggregate (Sand)

Table 3.4 Properties of Sand

S No.	Description of Tests	Results
1	Specific Gravity	2.62
2	Bulk Density	1690 Kg/m^3
3	Fineness Modulus	2.92

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I. Mix Design: The casting of the interlocking brick specimens has been prepared as per the below mentioned mix design.

Specimen Number	Specimen Type	Cement	Fly Ash	Glass Powder	Sand	Water
Specimen-1	Conventional Cement Brick	3.67 Kg	-	-	12.24 Kg	1.7 Liters
Specimen-2	5% Replacement of Cement with 2.5% Fly Ash and 2.5% Glass Powder	3.5 Kg	92 gm	92 gm	12.24 Kg	1.7 Liters
Specimen-3	10% Replacement of Cement with 5% Fly Ash and 5% Glass Powder	3.3 Kg	184 gm	184 gm	12.24 Kg	1.7 Liters
Specimen-4	15% Replacement of Cement with 7.5% Fly Ash and 7.5% Glass Powder	3.1 Kg	275	275	12.24 Kg	1.7 Liters
Specimen-5	20% Replacement of Cement with 10% Fly Ash and 10% Glass Powder	2.9 Kg	367	367	12.24 Kg	1.7 Liters

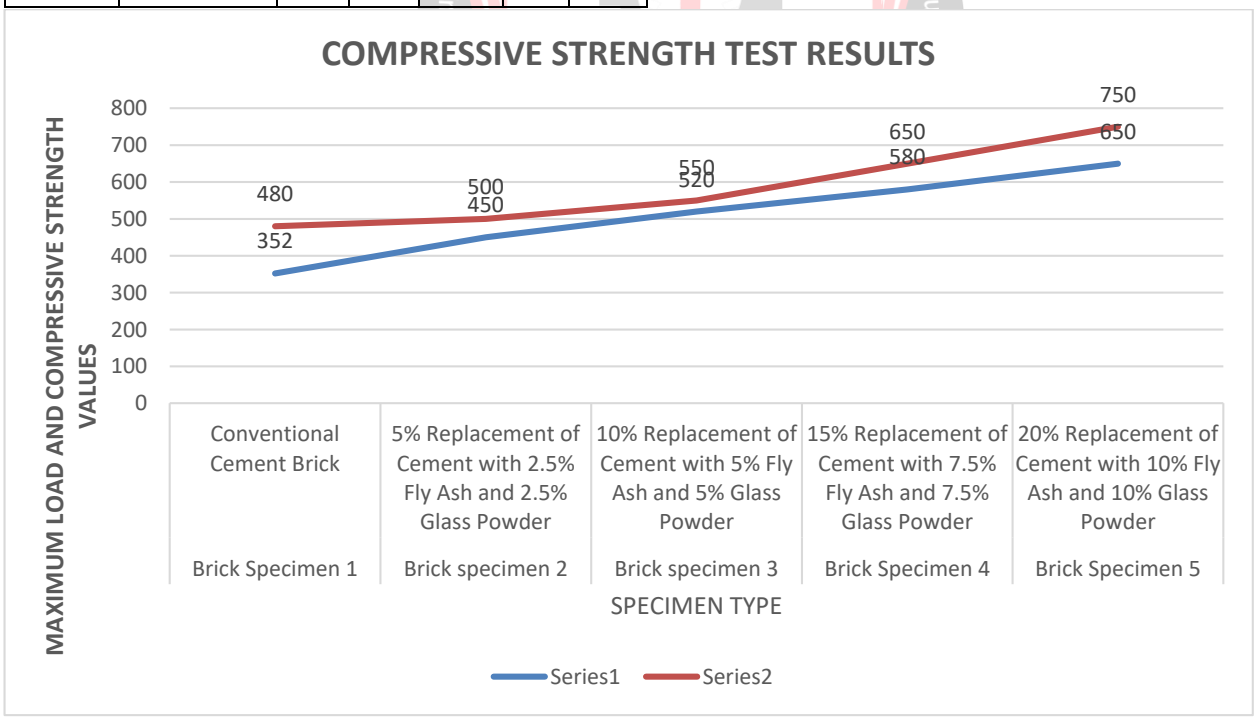
IV. RESULTS AND DISCUSSIONS:

All the casted specimens are tested for compression test as per the investigation and the test results has been compared keenly an the conclusions were made as per the results obtained.

5.1 Compressive Strength

Table 5.1 Compressive Strength Test Results in Mpa

Specimen type	Specimen Type	Maximum Load (KN)	Compressive strength (Mpa)
Brick Specimen 1	Conventional Cement Brick	352	480
Brick specimen 2	5% Replacement of Cement with 2.5% Fly Ash and 2.5% Glass Powder	450	500
Brick specimen 3	10% Replacement of Cement with 5% Fly Ash and 5% Glass Powder	520	550
Brick Specimen 4	15% Replacement of Cement with 7.5% Fly Ash and 7.5% Glass Powder	580	650
Brick Specimen 5	20% Replacement of Cement with 10% Fly Ash and 10% Glass Powder	650	750



Graph 5.1- Compressive Strength Test Results

V. CONCLUSION

The experimental investigation on interlocking bricks incorporating recycled glass powder and fly ash demonstrates that these waste materials can effectively enhance the bricks' strength, durability, and sustainability. The results indicate improved compressive strength, reduced water absorption, and better environmental performance

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compared to conventional bricks. The use of recycled glass powder enhances density and binding properties, while fly ash contributes to workability and cost reduction. Additionally, incorporating these materials promotes eco-friendly construction by reducing industrial waste and minimizing reliance on natural resources. Overall, this study confirms that interlocking bricks made with recycled glass powder and fly ash are a viable, cost-effective, and sustainable alternative for modern construction.

VI. REFERENCES

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