Experimental Concrete Brick Adding Glass, Plastic and Foundry Sand

I. INTRODUCTION:

Plastics and glasses are very common material that is now widely used by everybody in world. The great problem with plastic and glasses are its disposal. Plastics were made of polymer chemicals and they were not bio degradable. Which means that plastic will not decompose when it is buried? Though plastics have very useful materials that are flexible, tough and rigid they become waste after their use and they pollute the atmosphere. Recycling is the process that used materials (waste) into new products to prevent waste of potentially useful materials. Increase in the popularity of using environmental friendly, to protect the environment as well as to take the advantage of plastics and glasses recycling procedure where used. In this study, plastic, glass, Biochar and foundry sand will be used to incorporate concrete with to produce concrete bricks. The bricks will then be tested to study compressive strength and water absorption test as per IS 2185 part 2.

II. RELATED WORK

Glass is an amorphous material with a high silica content, making it potentially pozzolanic when ground to particles smaller than 90 µm. The main challenge in using crushed glass as aggregate in Portland cement concrete is the risk of expansion and cracking caused by alkali–silica reaction. However, due to its silica content, finely ground glass is considered a pozzolanic material and can exhibit properties similar to other pozzolans.

In this study, finely powdered waste glass is used as a partial replacement for cement in concrete and compared with conventional concrete. Plastics are also commonly used materials that play an important role in construction applications.

Moulding sand, also known as foundry sand, is another potential material. When moistened, compressed, oiled, or heated, it packs well and retains its shape, making it suitable for sand casting processes in preparing mould cavities. Foundry sand primarily consists of clean, uniformly sized, high-quality silica sand, and it is locally available from sources such as farmers, agricultural operations, or industrial suppliers.

Additionally, biochar should be ground into a fine powder to ensure consistency and uniform performance when used in mixtures.

Bonded to form moulds for ferrous (iron and steel) and nonferrous (copper, aluminum, brass) metal castings.

III. METHODOLOGY

For producing concrete blocks with ground plastic, ground glass, and biochar, the most effective method is to use these waste materials as partial replacements for conventional cement or aggregates. This approach not only manages waste and reduces the environmental impact of cement production but also contributes to lighter, better-insulated, and eco-friendly building materials.

The core objective of this project is to establish the sustainable use of plastic waste as a partial replacement for coarse aggregate, foundry sand as a partial replacement for fine aggregate, and glass powder as a partial replacement for cement in concrete production. It is essential to validate that these substitutions meet the required performance standards and produce durable, reliable concrete blocks.

Step 1: Source and process materials

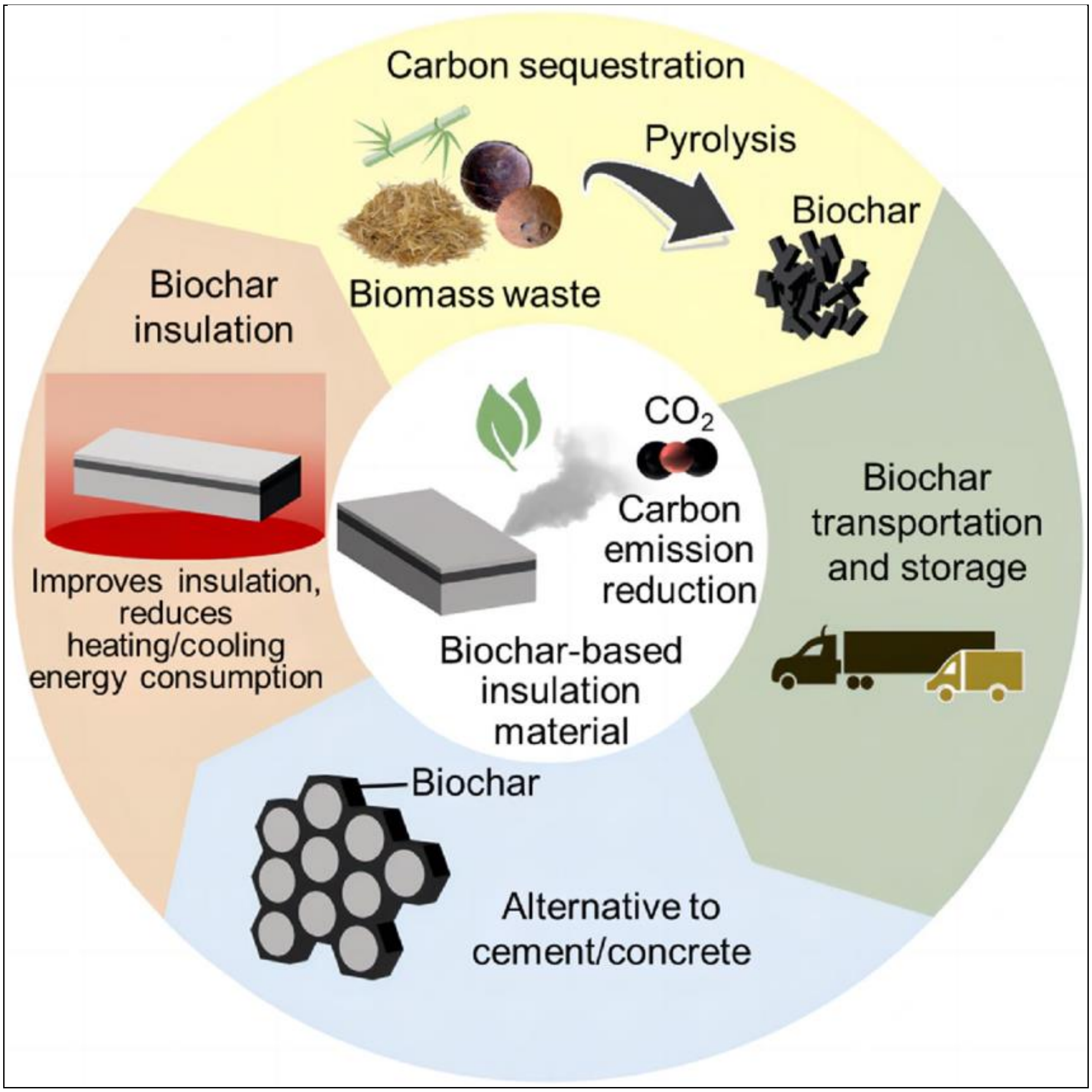
- **Recycled plastic:** Plastic waste was collected from household and industrial sources, with common types including high-density polyethylene (HDPE) and polyethylene terephthalate (PET). The collected plastic was manually crushed into pieces of 10–15 mm size, then cleaned, dried, and further ground into fine flakes or powder for use as a partial replacement of fine aggregate. Preliminary tests, including water absorption, sieve analysis, and specific gravity, were carried out to assess its suitability for the concrete mix.

- **Ground glass:** Waste glass powder can be collected from scrap dealers or glass manufacturing units. The collected glass powder is sieved through 90micron sieve to remove large sized glass particles. Grind the glass into a fine powder (less than 75 µm particle size) to use as a cement substitute, which allows it to exhibit pozzolanic properties that can enhance strength and durability. Initial and final setting time, fineness test, specific gravity and consistency tests were performed to matching with the properties of cement.

- **Biochar:** This material can be produced by heating biomass, such as agricultural waste or sawdust, in a low-oxygen environment (pyrolysis). Obtain.

Step 2: Formulate the mix

- **Replacement ratios:** Optimize the percentage of replacement to achieve desirable properties, keeping it below 10% in most cases. A 3% to 6% replacement of fine aggregate with plastic is typically recommended. For glass, studies show optimal results when replacing 10% to 15% of cement. Up to 5% biochar as a cement replacement can also enhance strength.



- **Adjusting the mix:** The addition of plastic and biochar, with their high porosity and absorption, will reduce the workability of the mix. This can be countered by adding a super plasticizer (Fig-1) to maintain the desired water-to-cement ratio.

(A super plasticizer is a chemical additive for concrete that significantly improves its fluidity and workability, allowing for a substantial reduction in water content (up to 30%) while maintaining or even enhancing the concrete's strength and durability. By dispersing cement particles, super plasticizers prevent them from clumping, resulting in a more pourable mix that requires less vibration, makes it easier to place in intricate forms, and leads to higher-strength, more durable, and less permeable concrete)

Step 3: Mix and cast concrete blocks

To mix these materials1:1.5:3 is selected and mould size of13x7x5 inches. Some bricks are made by replacing coarse aggregate by 5%, 10%, 15% and 20% with plastic (Fig-2) Some bricks are made by replacing cement by 8%,10%,12%,14%,16% and18%with glass powder. Some bricks made by replacing sand by 5%,10%,15%,20%,25% and 35%with foundry sand.

1. **Dry mix:** Thoroughly mix all dry ingredients, including cement, fine aggregates (sand, ground plastic, and glass powder), coarse aggregates, and biochar, until a uniform blend is achieved.
2. **Add water and super plasticizer:** Add water to the mixture in controlled amounts. If using, add a super plasticizer to improve workability.
3. **Pour into molds:** Pour the well-mixed concrete into block molds.

Vibrate and cure: Vibrate the molds to eliminate voids and compact the material. Cure the blocks in a controlled environment to ensure proper hydration. Curing with CO_2 can enhance carbon sequestration

After 21 days of curing, as per IS2185PART2 bricks retested. Compressive strength test and water absorption tests are carried as per IS 2185 PART 2. From these test results, we selected the adopted proportion for the final brick. Final experimental brick is made and completed the tests.

A B C

Fig. 2 showing making of final brick; (a) Batching of materials (b) placing of materials to mix machine (c) Mixing

D E F G

Fig. 3 showing making of final brick; (d) placing of mix in to the mould (e) compacting (f) prepared brick (g) Curing

Step 4: Apply stucco

1. **Prepare the surface:** Ensure the wall surface is clean and properly prepared. For blocks with added biochar, their porous structure can improve stucco adhesion.

2. **Apply and finish:** Apply the stucco using standard plastering techniques. Biochar-based stucco is lighter and can be applied with standard or specialized equipment.

A B

Fig.4 showing the tests of the brick Compression Strength Test (B) Water absorption Test

Table1 and 2 shows the preliminary test results of glass powder

Sl. No.	Tests	Cement	Glass powder
1	Specific Gravity	3.15g/cm3	2.38g/cm3
2	Fitness Test	1.9g	18g

Table1 specific gravity and fineness test of glass powder

% Of Glass added to cement	0%	5%	10%	15%	20%
Initial setting time of glass	30 min	53min	59min	1hr9min	1hr20min
Final setting time of glass	5hr22min	5hr45min	5hr48min	6hr25min	7hr21min

Table 2 setting time of cement on adding 5%, 10%, 15% and 20%

Sl. No	Tests	Fine Aggregate	Foundry Sand
1	Specific Gravity	2.68g/cm3	2.36g/cm3
2	Sieve Analysis		

Table 3 shows preliminary test results of foundry sand

Sl. No.	Tests	Coarse Aggregate	Plastic
1	Sieve Analysis	6.49	1.652
2	Water Absorption	0.32%	10.64%
3	Specific Gravity	2.89	1.34

Table 4 shows preliminary test results of plastic Table 5 shows the results of final brick

Sl. No.	Tests	Result
1	Compressive Strength Test	23Mpa
2	Water Absorption test	2.5%

Table 5 shows the results of compressive strength test and water absorption test.

The project is mainly focused on utilization of waste glass powder, plastic and foundry sand.

Benefits of using these materials

- **Environmental sustainability:** By diverting waste plastic and glass from landfills, this process reduces pollution and conserves natural resources like sand and limestone.
- **Improved properties:** The use of these additives can enhance the thermal insulation of blocks and stucco, creating cooler interiors and potentially reducing energy consumption. Biochar can also enhance the compressive strength of the composite when used in optimal amounts.
- **Circular economy:** This method aligns with the principles of a circular economy by turning waste into valuable building materials, which is a major focus of Construction and Demolition Waste Management.

Important considerations and challenges

- **Quality control:** The properties of waste materials can vary, necessitating consistent processing and quality checks to ensure the final products meet standards.
- **Regulatory compliance:** Stay up-to-date with local and national regulations regarding the use of recycled materials in construction. India's EPR rules and utilization targets for recycled C&D waste need to be followed.
- **Material properties:** High percentages of plastic can sometimes decrease compressive strength, while glass powder can cause alkali-silica reactions if not finely ground. Biochar can increase water absorption if not used in optimal concentrations. Careful mix design and testing are critical.
- **Lack of awareness:** Addressing the perception of lower quality in recycled materials through education and showcasing successful projects is crucial for market acceptance.

Requirement of Material and Machineries

III. CONCLUSION

Materials were tested for suitability in brick production. Foundry sand performed comparably to fine aggregate, plastics showed higher water absorption than coarse aggregate, and glass powder closely matched cement with slightly longer setting times. Bricks with 10% plastic and 10% glass powder replacements showed minimal strength loss, while 15% foundry sand replacement improved strength. The final mix resulted in lightweight, durable bricks with satisfactory performance.