Development Of Construction Bricks By Using Waste Materials

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Abstract: The construction industry is one of the largest contributors to environmental degradation, with substantial waste generated during building processes and raw material extraction. This research aims to address the growing concerns about waste disposal and the sustainability of construction practices by developing an innovative approach to brick production. The study explores using various waste materials such as industrial by-products, plastic, and glass as alternative raw materials to formulate construction bricks. These waste-derived bricks are tested for their mechanical properties to evaluate their potential as viable alternatives to conventional fired clay bricks. The research investigates the environmental benefits of using recycled materials in brick manufacturing. Preliminary results indicate that certain waste materials, when properly processed, can significantly enhance the strength and durability of bricks while reducing the carbon footprint and overall environmental impact of construction practices. The findings of this study offer promising insights into sustainable construction technologies and contribute to the broader goal of minimizing construction waste and promoting circular economy principles in the built environment.

Key Words: Waste material, Sustainable construction, Recycled material, Construction bricks, Environmental impact

Introduction: Brick is a building material used to make walls, pavements, and other elements in masonry construction. Since the large demand has been placed on building materials, especially in the last decade, owing to the increasing population, which causes a chronic shortage of building materials, people have been challenged to convert industrial wastes to useful materials such as building and construction materials. Accumulation of unmanaged wastes in developing countries increased environmental concern.

The construction industry is a significant contributor to environmental degradation, generating substantial waste and depleting natural resources. As the demand for sustainable building materials increases, the need to explore innovative solutions has become imperative. This project report focuses on the development of construction bricks using waste materials, an approach that not only addresses waste management challenges but also promotes eco-friendly construction practices. In this study, we investigate the potential of various waste materials - such as industrial by-products, various plastics, and glass as alternative raw materials for brick production. By repurposing these materials, we aim to reduce the environmental impact of traditional brick manufacturing, which is energy-intensive and heavily reliant on non-renewable resources.

Working Methodology

To revolutionize construction, our methodology for developing eco-friendly bricks from waste materials embarks on an innovative journey. We begin with an extensive literature review to uncover insights from existing sustainable material research. Next, we gather diverse waste materials and conduct thorough characterization to assess their properties. With this knowledge, we craft bespoke mix designs, blending these waste components with a suitable binder to form the backbone of our bricks. Using molding techniques, we will be producing these bricks and rigorously testing their mechanical and physical attributes. An environmental impact assessment will illuminate the sustainability benefits, while an economic analysis will reveal their cost-effectiveness against traditional bricks. Finally, we'll document our findings and present our project, showcasing a pioneering approach to sustainable construction that not only reduces waste but also builds a greener future.

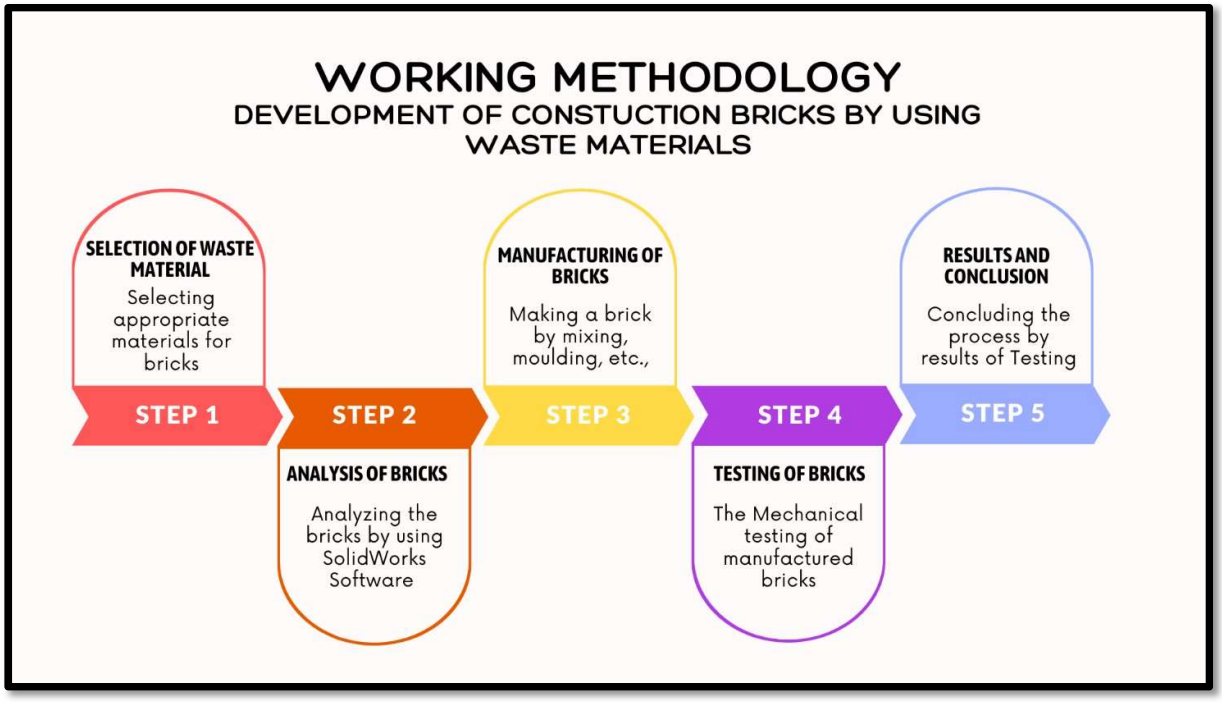

Fig no.1 Working Methodology

The working methodology involves a systematic five-step process. It begins with the selection of waste materials, such as glass, plastic, and mild steel chips, which are chosen for their potential to enhance brick properties. Next, the analysis of bricks is carried out using SolidWorks software to evaluate their structural and mechanical characteristics. The third step, manufacturing of bricks, involves mixing the selected waste materials with concrete, water, and sand, followed by molding them into bricks. These bricks then undergo mechanical testing, including compression tests with a load of 100 kN, to assess their strength and quality. Finally, in the results and conclusion phase, the performance of these bricks is compared to traditional ones to determine their feasibility as sustainable construction materials. This process not only promotes eco-friendly practices but also offers an innovative solution for effective waste management in the construction industry.

Selection Of Waste Materials

The selection of materials is crucial in developing construction bricks that are both sustainable and high-performing. In this project, we focus on three primary waste materials: plastic, industrial scrap, and glass. Each material will be evaluated based on availability, properties, and compatibility with binder materials.

1) **Plastic:-** The plastic we are using in this project is commonly sourced plastic including High-Density Polyethylene (HDPE) from containers, PVC pipes, etc., and mixed plastics (from packaging). Plastic needs to be cleaned and shredded into small particles to ensure even distribution within the brick matrix.

Properties :

- Lightweight: Reduce the overall weight of the bricks.
- Durability: Offer resistance to moisture and some chemical exposure.
- Insulating Properties: Enhance thermal insulation, contributing to energy efficiency.

Fig no 2. Plastic

2) **Industrial Waste:-** This category may include scrapes developed from manual lathe machines, cutting machines, and drilling machines. This scrape contains metal shavings or other byproducts from manufacturing processes. Mainly the metal scrape contains the Cast Iron (CI).

Properties :

- Strength: Certain industrial scraps can enhance the structural integrity of bricks.
- Recycling Potential: Using these materials contributes to waste reduction in industrial settings.
- Thermal Conductivity: Depending on the type, industrial scraps can improve the thermal properties of bricks, enhancing insulation or heat resistance.
- Cost Efficiency: Industrial scrap is often available at a lower cost than virgin materials, potentially reducing the overall production costs of bricks.

Fig no 3. Mild steel

3) **Glass:-** Sources may include recycled glass bottles, window panes, and other glass products. The glass waste we are using in the project is crushed into small pieces so that they can be used in bricks.

Properties :

- Strength and Hardness: Glass can significantly enhance the compressive strength of bricks.
- Low Water Absorption: Glass particles tend to absorb very little water, which can contribute to lower porosity in the final brick product, enhancing durability and resistance to moisture-related issues.
- Compatibility with Binders: Glass can bond well with various types of binders, enhancing the structural integrity of the bricks.

Fig no 4. Glass

Analysis Of Bricks

The analysis of the following bricks was conducted by using SolidWorks Software and they were tested under the compression load of 100KN. Following are the visuals of the analysis.

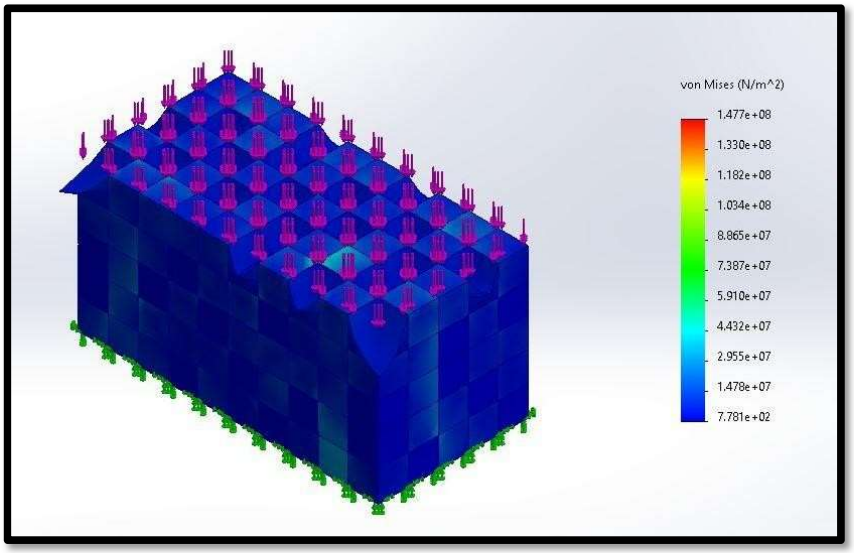

Fig no 5. Brick 1
Composition : concrete + sand + glass + mild steel

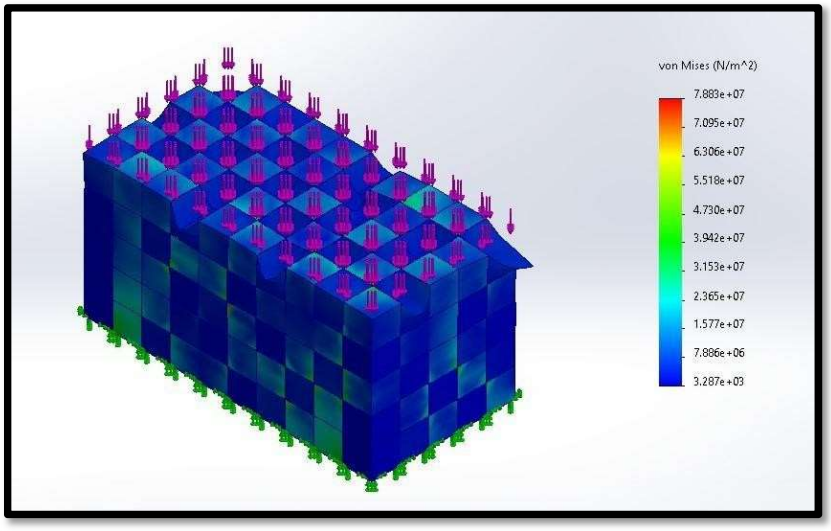

Fig no 6. Brick 2
Composition : concrete + sand + glass + plastic

Manufacturing Of Bricks

The manufacturing process of bricks in this project follows a systematic approach to ensure both sustainability and functionality. The process begins with the use of a specially designed mold, measuring 190 mm x 90 mm x 90 mm, which standardizes the shape and size of the bricks for consistency. Two types of bricks were manufactured, each with a unique composition to evaluate the potential of different waste materials in construction applications. Brick No. 1 was produced using a combination of concrete, sand, glass, and mild steel chips. The inclusion of mild steel chips not only utilizes industrial waste but also potentially enhances the strength and load-bearing capacity of the brick. This combination is aimed at producing a durable and structurally sound material for construction purposes.

Brick No. 2, on the other hand, was created using concrete, sand, glass, and plastic waste. By incorporating plastic, which is a significant contributor to environmental pollution, this brick seeks to address the growing challenge of plastic waste management. The recycled plastic adds to the sustainability of the project while also potentially improving the thermal insulation properties of the brick. Both types of bricks were meticulously mixed and molded, ensuring a uniform distribution of materials for optimal performance. This innovative process demonstrates how waste materials, which are often discarded and contribute to environmental degradation, can be repurposed into valuable construction materials. By combining environmental sustainability with practical application, this project showcases a significant step toward eco-friendly construction practices and effective waste management solutions.

Fig no 7. Manufactured bricks

Testing Result

Sample	Crushing Load (KN)	Compressive Strength (N/mm2)
1	67.3	4.06
2	127.5	7.35
Average	97.4	5.71

Table 1 Brick no 1

Sample	Crushing Load (KN)	Compressive Strength (N/mm2)
1	83.5	4.66
2	62.8	3.55
Average	73.1	4.10

Table 2 Brick no 2

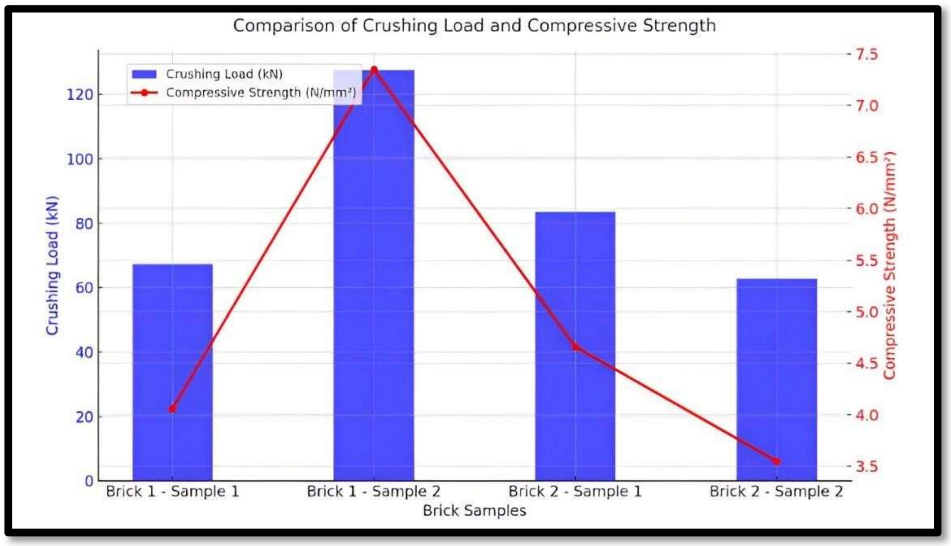

Fig no 8. Comparison graph of test results

The testing results provide an insightful comparison of the mechanical properties of Brick No. 1 and Brick No. 2, with a focus on crushing load and compressive strength. Brick No. 1 demonstrated superior performance overall, with an average crushing load of 97.4 kN and an average compressive strength of 5.71 N/mm². The second sample of Brick No. 1 notably achieved the highest values among all samples, recording a crushing load of 127.5 kN and a compressive strength of 7.35 N/mm².

In contrast, Brick No. 2 exhibited lower values, with an average crushing load of 73.15 kN and an average compressive strength of 4.10 N/mm². The first sample of Brick No. 2 performed better than the second, recording a crushing load of 83.5 kN and a compressive strength of 4.66 N/mm², while the second sample had a compressive strength of 3.55 N/mm².

According to Indian standards, the minimum compressive strength requirement for construction-grade concrete bricks is 3.5 N/mm², which both bricks successfully exceeded. However, Brick No. 1's higher performance makes it a more viable option for applications requiring greater load-bearing capacity and strength. The testing was conducted at ELCA Laboratories, Mahape, ensuring accurate and reliable results. These findings highlight the potential of Brick No. 1, which utilizes waste materials like mild steel chips, as a robust and sustainable alternative in construction.

Conclusion

- We created a construction brick using SolidWorks and analyzed it under a 100KN compression test. In that analysis brick with mild steel composition bore more load than plastic brick**.**
- We developed 2 bricks with the composition of mild steel and 2 bricks with the composition of plastic for testing.
- Physical brick models were developed with different waste material combinations and tested at ELCA laboratories, Mahape.
- Analysis showed that bricks with mild steel composition exhibited the highest compressive strength (7.35 N/mm2).
- All 4 samples are applicable for general building constructions, but Sample 2 of Brick 1 qualifies for load-bearing applications.

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References

1) **MOHAMMAD SHAHID ARSHAD, DR. P.Y. PAWADE (2014)** Reuse Of Natural Waste Material For Making Light Weight Bricks, International Journal Of Scientific & Technology Research Volume 3, Issue 6, June 2014.

2) **N. SUDHARSAN1 AND T. PALANISAMY (2018)** A Comprehensive Study On Potential Use Of Waste Materials In Brick For Sustainable Development. Eco. Env. & Cons. 24 (February Suppl.) : 2018.

3) **ROHIT KUMAR ARYA1 , RAJEEV KANSAL (2016)** Utilization Of Waste Papers To Produce Ecofriendly Bricks. International Journal of Science and Research (IJSR) Volume 5 Issue 8, August 2016.

4) **ASHISH KUMAR PARASHAR, RINKU PARASHAR (2012)** Comparative Study of Compressive Strength of Bricks Made With Various Materials to Clay Bricks. International Journal of Scientific and Research Publications, Volume 2, Issue 7, July 2012.

5) **MEBRAHTOM TEKLEHAIMANOT , HAREGEWEYNI HAILAY AND TAMRAT TESFAYE (2021)** Manufacturing of Ecofriendly Bricks Using Micro-dust Cotton Waste. Hindawi Journal of Engineering Volume 2021.

6) **ADITYA SINGH, ASHISH KUMAR SRIVASTAVA , GYANENDRA SINGH (2023)** Utilization of Plastic Waste for Developing Composite Bricks and Enhancing Mechanical Properties. Advances in Polymer Technology Volume 2023.