
Section 1: Administrative and Core Identity

Project Title**Eco-Innovation in Construction: Alkali Activated Bricks from Industrial By-Products****Student Team**

Sl. No.	Student Name	Role in Project
1	Sanath S Rayar	Team Head
2	Punya L K	Team Member
3	Samar Firdose	Team Member
4	Thushar K P	Team Member

Academic Details

Student Name	Program	Department	Status
Sanath S Rayar	B.E.	Civil Engineering	Graduated – 2025
Punya L K	B.E.		Graduated – 2025
Samar Firdose	B.E.		Graduated – 2025
Thushar K P	B.E.		Graduated – 2025

Institution**College:** Malnad College of Engineering, Hassan**Project Duration****Dates:** January 2025 – March 2026**Mentor****Name:** Siri Hemanth, Assistant Professor, Civil Engineering, Malnad College of Engineering, Hassan**Funding****Grant Approved:** ₹1,00,000**Contact****Team Head:** Sanath S Rayar, **Email:** Sanathroy48@gmail.com

Section 2: Visual Assets (High Resolution Requirements)

Student / Team Profile Photos

Primary Project Image



Process Photos (2–3)



Section 3: Narratives

The Hook

“Minimisation of carbon emissions by using alkali activators, which help absorb carbon dioxide from the atmosphere.”

Problem Statement

Conventional brick manufacturing heavily depends on the extraction of fertile clay soil and energy-intensive kiln firing, leading to severe environmental degradation, depletion of topsoil, and high carbon emissions. In India alone, massive quantities of agricultural soil are consumed annually for brick production, contributing to land infertility and ecological imbalance.

Simultaneously, industrial by-products such as fly ash and waste foundry sand are generated in large volumes and disposed of in landfills, causing air, soil, and groundwater pollution.

The challenge is to develop a sustainable brick manufacturing solution that reduces dependence on virgin clay, minimises landfill waste, lowers the carbon footprint, and maintains required mechanical and durability standards. This issue significantly affects the construction industry, environmental agencies, agricultural sectors, and communities impacted by pollution and resource depletion.

Proposed Solution

The developed solution is a sustainable geopolymer-based brick manufactured using waste foundry sand, fly ash, clay soil, and alkali activators such as potassium hydroxide. This formulation partially replaces virgin clay with industrial by-products, significantly reducing soil consumption and landfill disposal.

The process begins with material characterisation to ensure proper grading and pozzolanic activity. The dry constituents are uniformly blended, and an alkali solution is then added to initiate geo-polymerisation, enhancing particle bonding at the microstructural level. The mixture is moulded into standard brick

dimensions, compacted to eliminate voids, air-dried to control shrinkage, and fired between 850°C and 1000°C to achieve structural stability.

The resulting bricks demonstrate enhanced mechanical strength, improved thermal insulation, lower production cost, and reduced carbon emissions compared to conventional clay bricks — making them a viable, scalable solution for sustainable construction practices.

The optimised mix design proportions are summarised below:

Constituent	Proportion Range	Function
Clay Soil	50–59%	Base binding matrix
Waste Foundry Sand	23–40%	Dimensional stability, durability
Fly Ash	5–20%	Pozzolanic bonding, compressive strength
Potassium Hydroxide (Alkali)	Controlled dosage	Geo-polymerisation and chemical resistance

Methodology and Key Technology

The project followed a structured experimental approach across seven key stages:

#	Stage	Details
1	Material Characterisation	Specific gravity, fineness modulus, moisture content, particle size distribution
2	Optimised Mix Design	Proportioning of soil, fly ash, and waste foundry sand with controlled alkali dosage
3	Alkali Activation	Potassium hydroxide solution to enhance bonding and strength
4	Moulding & Compaction	Standard brick moulds (190 × 90 × 90 mm) for uniform density
5	Drying & Kiln Firing	Controlled drying followed by firing at 850–1000°C
6	Performance Testing	Compressive strength, water absorption, density, efflorescence, thermal conductivity
7	Sustainability Assessment	Carbon footprint analysis and waste utilisation evaluation

Key Findings and Results

The developed sustainable bricks demonstrated significant structural and environmental improvements compared to conventional clay bricks. Mixes containing 15–20% fly ash showed enhanced compressive strength due to improved pozzolanic bonding, while waste foundry sand (up to 40%) reduced shrinkage and improved dimensional stability.

Water absorption values decreased, indicating better durability and resistance to weathering. The optimised compositions achieved adequate load-bearing capacity within a density range suitable for structural applications.

The table below compares conventional clay bricks against the alkali-activated bricks developed in this project:

Parameter	Conventional Clay Bricks	Alkali-Activated Bricks
Virgin Soil Consumption	100%	Reduced by up to 40%
Industrial Waste Utilisation	None	Fly ash + foundry sand reuse

Parameter	Conventional Clay Bricks	Alkali-Activated Bricks
Compressive Strength	Standard	Enhanced (15–20% fly ash mixes)
Water Absorption	Higher	Lower (improved durability)
Shrinkage / Dimensional Stability	Moderate	Improved (foundry sand effect)
Production Cost	Baseline	Reduced by ~2–5%
Carbon Emissions	High (kiln + clay extraction)	Lower (waste substitution)
Landfill Waste Impact	No contribution	Significant waste diversion

This project successfully developed an eco-friendly, cost-effective, and mechanically reliable brick alternative aligned with sustainable construction objectives.

Future Scope and Next Steps

Future work will focus on large-scale industrial trials to validate long-term durability and structural performance under field conditions. Optimisation of alkali activation and firing temperature can further reduce energy consumption and carbon emissions.

A detailed life cycle assessment and cost–benefit analysis will support commercialisation. Collaboration with brick manufacturers and local construction agencies is planned for pilot deployment in low-cost housing projects.

Further research may explore fully unfired geopolymer bricks to eliminate kiln firing, enhancing sustainability and scalability for widespread community adoption.