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Redone Bricks: An Innovative Low-Carbon, Lightweight Construction Material Synthesized from Industrial and Organic Waste

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Abstract- Redone Bricks are a novel, sustainable construction material engineered to address the urgent need for low-carbon alternatives in the building industry. Developed from a mix of quick lime, C&D waste, plastic waste, fly ash, aluminium powder, agricultural waste, and Indian Bedellium (Guggul), these bricks are designed to outperform conventional materials in both environmental impact and mechanical properties. A comparative study was conducted against six alternatives: Stabilized Mud Blocks (SMBs), Conventional Clay Bricks, Fly Ash Bricks, Autoclaved Aerated Concrete (AAC) Bricks, Fiber-Reinforced Composite (FRC) Bricks, and Plastic Bricks. Redone Bricks demonstrated superior performance with low weight (1.2 lbs), excellent thermal insulation (2–2.5 m^2•K/W), reduced water absorption (20%), and high compressive strength (4.3 N/m^2). Priced affordably at INR 8 per unit, they offer economic as well as environmental benefits. Critically, Redone Bricks exhibit a remarkably low CO_2 emission of just 0.00206 kg/kg, representing a >99% reduction compared to conventional materials: Fired Clay Bricks (0.335 kg/kg), AAC Blocks (0.23 kg/kg), SMBs and Plastic Bricks (0.48 kg/kg), and even Fly Ash Bricks (0.0228 kg/kg). This positions Redone Bricks as the most environmentally friendly option in the study. Overall, Redone Bricks offer a better path toward greener construction, combining sustainability, performance, and affordability—making them an ideal solution for climate-resilient infrastructure.

Keywords- Redone Bricks; Sustainability; Fly Ash; Aircrete; Plastic Waste

I. INTRODUCTION

The construction industry has long relied on using a large amount of energy (30-40% of society's total energy), water, and raw materials globally. In 2022, approximately 37% of global energy and process-related carbon dioxide emissions came from the building sector (1). Direct carbon dioxide emissions accounted for about 3Gt in 2022, while approximately 2.5Gt2.5 Gt of CO2 emissions were associated with building construction, primarily due to the production of materials such as cement, steel, and aluminum (2). The reasons behind surplus carbon dioxide emissions are due to the high energy consumption of the processes involved in the extraction, production, and transportation of raw materials. Additionally, the production and use of materials such as cement, steel, and aluminum have a significant carbon footprint (3).

Typically, fired and unfired clay bricks have been used in the construction industry. However, fired clay bricks require a lot of energy for production. Unfired clay bricks are often used to lessen the environmental impacts and achieve sustainable building industry development, as they are composed of clay soils and a binder such as lime or cement. Stabilized Mud Blocks (SMBs), also known as Pressed Earth Blocks. SMBs are made primarily from damp soil that is mechanically compressed at high pressure to form durable blocks suitable for construction. When stabilized using a chemical binder such as Portland cement, these blocks are classified as Compressed Stabilized Earth Blocks (CSEB) or Stabilized Earth Blocks (SEB)(4) [1]. These materials offer a sustainable alternative to conventional bricks by utilizing naturally available sub-soil and minimizing energy consumption during production. However, the production of these bricks involves the depletion of fertile topsoil, high energy consumption through kiln drying, and the use of materials that require extensive mining, resulting in voids that may contribute to ecological imbalances and natural disasters. Furthermore, conventional bricks are often heavy, brittle, and lack sufficient tensile strength, thereby increasing the dead load of buildings and compromising structural efficiency.

To overcome this issue, the development of an alternative brick is proposed in this paper. This research focuses on the development of Redone Bricks—a sustainable, innovative construction material engineered to replace conventional bricks. Redone Bricks are composed of a blend of mud, cement, construction debris, lime, fly ash, plastic waste, and organic waste, offering a viable solution to reduce the carbon footprint and dead load of buildings. These bricks are designed to be lightweight, cost-effective, and climate-friendly, supporting the global shift toward sustainable and eco-efficient construction practices. The development of these bricks involves a systematic and multi-phase approach to ensure the technical feasibility, sustainability, and scalability of the proposed material. Redone bricks are usually manufactured by identifying locally available raw materials such as mud, cement, construction debris, lime, fly ash, plastic waste, and organic waste. Below is the step-by-step breakdown of the materials used and their specific role in Redone brick development:

Lime plays a key role in the chemical composition of Redone bricks. Lime undergoes the lime cycle, where limestone ($CaCO_3$) is heated to produce quicklime (CaO). Adding water to quicklime produces hydrated lime ($Ca(OH)_2$). In the presence of carbon dioxide (CO_2), hydrated lime reacts to reform limestone. This cycle is essential for achieving the chemical reactions necessary for the bricks' binding properties. Lime cycle
(5):[9]

$CaCO_3 + \text{heat} \leftrightarrow CaO + CO_2$

$CaO + H_2O = Ca(OH)_2 + \text{heat}$

$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$

Mud has been a construction material for centuries, offering an abundant and sustainable option. It is used in various forms, such as monolithic or unit-based structures. Mud contributes to the natural, breathable properties of the Redone bricks. This historic material is abundant, non-detrimental to agriculture, and can be sourced locally, making it a key resource for environmentally conscious construction (6) [10]. Construction and demolition (C&D) waste (7) [11], a significant portion of solid waste, is often discarded in landfills. Redone bricks recycle C&D debris such as concrete, rubble, and tiles, contributing to waste reduction. Recycled concrete aggregates offer increased durability and lower environmental impact. In India, the vast amounts of C&D waste, especially concrete and sanitary ware, are now being repurposed for brick production. Plastic waste is a significant environmental issue. Redone bricks incorporate waste plastics, such as polyethylene (LDPE), and use them as filler material. This not only reduces plastic waste but also enhances the brick's properties by improving workability and providing water resistance. By recycling household plastics, the brick manufacturing process contributes to reducing landfill waste. Fly ash is a byproduct from coal combustion in thermal power plants. This particulate material is rich in silicon, aluminum, and iron oxides, and it enhances the strength and durability of Redone bricks. Fly ash also reduces the carbon footprint of production, making it an eco-friendly alternative to natural aggregates in concrete production. Depending on its composition, fly ash can be classified into Class F or Class C fly ash. Aluminum powder is crucial in the creation of porous, lightweight bricks. By reacting

with hydrated lime (Ca(OH)2) and water, aluminum powder facilitates the formation of gas bubbles, creating a cellular structure. This reaction is vital for producing lightweight Redone bricks that retain strength while reducing weight. Chemical reaction:
$Ca(OH)_2 + 2Al + 2H_2O \rightarrow Ca(AlO_2)_2 + 3H_2$

Agricultural waste, including plant residues like straw and weeds, is abundant and often discarded. Redone bricks utilize these waste materials to reduce environmental strain while adding to the material's insulation and binding properties. Agricultural waste, being organic (8)[3], is easy to source and contributes to the overall sustainability of the brick.

Indian Bedelium, or Guggul, is a resin obtained from the Commiphora wightii plant, traditionally used in Ayurvedic medicine (9)[3]. The resin is utilized in the formulation of Redone bricks for its binding properties and durability. Its inclusion adds a natural and sustainable element to the brick, enhancing its resistance to weathering and degradation

Figure 1: Materials for the development of Redone bricks: a) Lime, b) C&D Debris, c) Plastic Debris, d) Fly Ash, e) Aluminum Powder, e) Guggul, f) Agricultural Waste

These materials were collected from various sources and prepared for analysis. A comprehensive analysis of the physical and chemical properties of the materials was conducted. Apart from developing Redone bricks, this study compares them with alternative building materials, including conventional bricks, fly ash bricks, AAC blocks, aircrete bricks, and fiber-reinforced concrete (FRC). Conventional Bricks are composed of silica (50–60%), alumina (20–30%), lime (<5%), magnesia (~1%), and iron oxides. They are durable and widely available, but excess silica makes them brittle, too much alumina causes shrinkage, and high lime content leads to deformation. Apart from this, Fly Ash Bricks contain fly ash (60–80%), lime (10–25%), gypsum (5–12%), and sand or cement. They are lightweight, durable, and reduce mortar and plaster use, but they require controlled curing, and initial production costs can be high. Additionally, AAC Blocks consist of fly ash (59%), cement (33%), lime (8%), gypsum, aluminum powder (0.07%), and water. They offer excellent thermal insulation, fire resistance, and cost savings in construction, but they have lower tensile strength and require specialized handling.

Aircrete Bricks are made from cement, sand, aluminum powder, and water, with the aluminum reacting to create a cellular structure filled with air pockets. They are extremely lightweight, provide excellent thermal insulation, and reduce construction costs due to their easy workability. However, they have lower compressive strength compared to traditional bricks and require special adhesives for bonding.

FRC (Fiber-Reinforced Concrete) incorporates steel, glass, or synthetic fibers in concrete to enhance ductility, crack resistance, and impact tolerance. It improves structural integrity and reduces shrinkage but is more expensive and does not replace traditional reinforcement.

II. MATERIALS AND METHODOLOGY

1. Materials Required

Lime ((Ca(OH)2)), Mud, Construction and Demolition Waste (C&D), Plastic waste- PETE (Polyethylene terephthalate), HDPE (High-density polyethylene), PVC (Polyvinyl chloride), LDPE (Low-density polyethylene), PP (Polypropylene), Polycarbonate Polylactic, Fly Ash, Aluminum powder, Agricultural waste- Straw and weeds, Indian Bedelium (Guggul).

2. Methodology

The dimensions of traditional bricks, typically 220x110x75mm, have been refined over centuries by experienced masons to ensure ease of use, compatibility with construction techniques, and structural reliability.

To manufacture the Redone bricks, a specific protocol was followed using the materials listed in Table 1. Lime was heated at 950°C to form quicklime (CaO) and then hydrated to produce calcium hydroxide ($Ca(OH)_2$), which will serve as a crucial binding agent. Next, mud was processed and sieved to achieve a fine, uniform texture, while construction debris was crushed and refined to ensure consistency. Plastic waste was melted and integrated as a filler material to enhance durability and water resistance. Fly ash, collected from thermal power plants, was incorporated to improve strength and sustainability. Additionally, aluminum powder was used to ensure that it reacts with hydrated lime, wherein it will create gas bubbles to form a porous structure, thereby reducing the overall weight of the bricks. Agricultural waste was blended in to improve insulation and facilitate the drying process, while Indian Bedelium (Guggul) was added as a natural binding agent, enhancing the brick's durability and weather resistance.

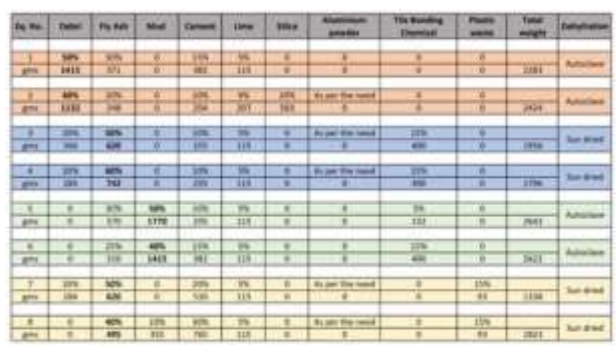
The materials were proportionally mixed and combined with water to achieve the desired consistency. The Drop test was performed to ensure that the ideal consistency was obtained. The mixture was then poured into molds manually to ensure uniform shaping. The molded bricks were left to undersun dried (40-50°C) for 7-14 days controlled conditions for 7–14 days to remove excess moistureallow excess moisture to evaporate. The final strengthening process involved burning the bricks using controlled heating at 750–1000°C to ensure high strength and durability. The dimensions of traditional bricks, typically 220 x 110 x 75 mm, have been refined over centuries by experienced masons to ensure ease of use, compatibility with construction techniques, and structural reliability. The same dimensions were used to manufacture the bricks. The quantity of the parameters was determined experimentally.

The developed bricks were assessed for their density (kg/m^3), durability (kg/cm^2), compressive strength (N/m^2), weight (pounds), thermal insulation (m^2•K/W), water absorption (compared to regular bricks), and cost-effectiveness (INR/cm^3).

To better understand the effectiveness of Redone bricks, a comparison with conventional brick structures and other eco-friendly alternatives such as Stabilized Mud Blocks (SMBs), Fly Ash Bricks, AAC Blocks, FRC Blocks, Bricks from Plastic Waste, and Aircrete Bricks is crucial.

Table 1: Materials used for the development of Redone bricks

Material	Weight
Lime	15-20%
Mud	25-30%
Construction Debris	20-25%
Plastic Waste	5-10%
Fly Ash	10-15%
Aluminum Powder	1-3%
Agricultural Waste	5-7%
India Bedelium	1-3%



Characterization of the Redone Bricks

For density measurement, the brick sample was first dried completely in an oven at 105°C to remove any moisture. The dry weight (W) of the brick was then measured using an electronic weighing balance with an accuracy of ±0.01 g. The brick's dimensions (length, width, and height) were measured using a Vernier caliper or a measuring scale to determine its volume (V). Density is calculated using the formula: Density (kg/m^3) = W/V, ensuring that each measurement is repeated for at least five samples for accuracy (10,11).

The durability test was conducted to assess the resistance of bricks to weathering; thus, each sample underwent cyclic wetting and drying. The bricks were immersed in water for 24 hours, followed by drying in an oven at 105°C or exposure to direct sunlight for another 24 hours. This cycle is repeated up to 10 times, and the weight loss was is recorded after each cycle. A weight loss of less than 5% indicates good durability. Additionally, impact resistance was tested by dropping the bricks from a standard height of 1.5 meters onto a hard surface and evaluating visible cracks or fragmentation (12,13).

For the compressive strength test, the brick sample was placed between the plates of a Universal Testing Machine (UTM), ensuring uniform load distribution. A compressive load was applied at a steady rate of 2.5 kN/sec until the brick fractures. The peak load (P) before failure was recorded, and compressive strength was calculated using the formula: Compressive Strength (N/m^2) = P / A, where A is the surface area of the brick. This test was repeated for at least five samples to obtain an average value (14,15).

For the weight measurement, each dried brick was weighed using a digital weighing scale with an accuracy of ±0.1 g. The weight was recorded in pounds, and variations in weight among samples were analyzed to ensure consistency (16,17).

The thermal resistance of bricks was measured using a heat flow apparatus. A brick sample was placed between two temperature-controlled plates, one heated to 50°C and the other maintained at room temperature (~25°C). The heat flux passing through the brick was recorded over time. Thermal insulation (m^2•K/W) was calculated based on Fourier's Law of heat conduction, using the steady-state temperature difference and the measured heat transfer rate (18,19).

To assess the water absorption, each brick was first dried in an oven at 105°C for 24 hours and weighed (W_1). The bricks were then submerged in water for 24 hours, ensuring full immersion. After removal, excess surface water was wiped off, and the bricks were immediately weighed again (W_2). Water absorption was calculated using the formula:

$$\text{Water Absorption (\%)} = ((W_2 - W_1) / W_1) \times 100 \qquad \text{.................................(1)}$$

where a higher percentage indicates higher porosity and lower moisture resistance (20).

The manufacturing cost of each brick, including raw materials, labor, and energy consumption, was calculated per batch. The cost per brick is divided by its volume to determine cost-effectiveness (INR/cm^3). This value was compared across different brick types to assess affordability.

To ensure reliability and accuracy, each test was conducted on at least five randomly selected samples, and results were averaged. Standard deviation calculations are performed to quantify variations. The obtained values were compared with established standards such as IS 1077 (Indian Standards) and ASTM C62 (American Standards) for bricks to validate the performance characteristics.

4. Assessment of Carbon Footprint Reduction

To calculate the CO2 emissions for the redone bricks composed of the materials listed in Table 1, the emission factors (CO2/Kg) for each material and the emissions of redone bricks based on the % composition in the bricks.

The emission factor of each material in the redone bricks are given in Table 3:

Table 3: CO2 emission factors of the materials used for developing Redone bricks

Material	Emission Factor (kg CO_2/kg)
Lime	0.079
Mud	Negligible
Construction Debris	0.24
Plastic Waste	24.4
Fly Ash	Negligible
Aluminium Powder	8.24
Agricultural Waste	Negligible
India Bedelium	Negligible

Table 4 consists of the average values considered for the calculation of the emissions

Table 4: Average values of the materials used for the development of Redone bricks

Lime	17.5%
Mud	27.5%
Construction Debris	22.5%
Plastic Waste	7.5%
Fly Ash	12.5%
Aluminium Powder	2%
Agricultural Waste	6%,
India Bedelium	2%.

The following equation was used to calculate the total CO2 emissions:

Total CO2 emissions=∑ (Material Percentage × Emission Factor)……………………..(2)

Additionally, the following data for the CO2 emissions of alternative bricks were considered. Conventional fired clay bricks typically result in approximately 335 kg of CO_2 emissions per ton of brick (21). AAC blocks have an embodied carbon of approximately 0.23 kg CO2/kg, which is slightly lower than traditional clay bricks at 0.24 kg CO2/kg. The global average for SMBs' emissions is estimated at 0.48 kg CO_2 per kg, or 480 kg CO_2 per ton, based on global production data. Based on the above range, the carbon footprint for FCBs is approximately 70–340 kg CO2 per ton (22). Plastic bricks, such as PlastiQube, have significantly lower carbon footprints compared to traditional fired clay bricks. Fired clay brick production emits approximately 0.48 kg CO2 per kg of brick, equating to 480 kg CO2 per ton (23).

Aircrete bricks, a type of lightweight concrete block, generally have a lower carbon footprint compared to traditional fired clay bricks, with estimates ranging from 14 to 26 kg CO2/m2, according to the British Ceramics Confederation (24).

Fly ash has a carbon emission factor of approximately 22.8g CO_2/kg when used as a by-product in electricity generation (25). The demolition of debris contributes approximately 24.4 kg CO_2 per kg of construction area. For high-calcium lime, the emission factor is approximately 746 kg of CO2 per tonne produced (26).

The following equation was used to calculate the % reduction in CO2 emissions:

% reduction in CO2 emissions: (CO2 emissions of Redone bricks- CO2 emissions of alternative bricks)/CO2 emissions of Redone bricks) *100………………………..(3)

III. RESULTS AND DISCUSSION

1. Characterization of the Redone bricks

The Redone bricks have a density of 1100 kg/m^3, a durability ranging between 10-20 kg/cm^2, and a compressive strength of 4.3 N/m^2. They weigh approximately 1.2 pounds and offer thermal insulation in the range of 1 to 1.5 m^2•K/W.

2. Comparative Study of the Redone Bricks with Other Building Materials

The development of Redone bricks using innovative materials such as construction debris (C&D), aluminum powder, fly ash, lime, plastic fibers, and agricultural waste demonstrated significant advantages in terms of strength, sustainability, and cost-efficiency. The efficiency of Redone bricks against the different building materials is listed in Table 2.

Parameters	Redone	Stabilized Mud Block (SMBs)	Conventional Bricks	Fly Ash Bricks	ACC Bricks	FRC Bricks	Plastic Waste Bricks	Aircrete Bricks
Density (kg/m)	1100	1800	1900	1700	850	650	203	730
Durability (kg/cm^2)	10-20	2-5	5-15	5-7	15-25	20-25	30-55	30-45
Compressive Strength (N/m^2)	4.3	4.1	3.1	3.5	4.5	4.8	4.2	4.2
Weight (Pounds)	1.2	1.5	1.3	1.5	1.2	1.6	0.8	1.1
Thermal Insulation (m^2·K/W)	2-2.5	0.5-1.9	1-1.7	1.2-2.1	1.4-1.9	1.9-2.8	1.5-2.0	1.8-2.2
Water Absorption (Compare with Regular Brick Std.)	20%	80%	60%	75%	40%	25%	5%	32%
Cost Effectiveness (INR/km-+)	8	15	23	18	29	29	10	40

The Redone Stabilized Mud Blocks (SMBs) have a density of 1100 kg/m^3, which is lower than conventional and fly ash bricks but higher than aircrete and plastic waste bricks. In terms of durability, SMBs exhibit a strength range of 10-20 kg/cm^2, significantly outperforming conventional bricks (2-5 kg/cm^2) and fly ash bricks (5-15 kg/cm^2), while being comparable to fiber-reinforced concrete (FRC) bricks (20-25 kg/cm^2) and plastic

waste bricks (30-55 kg/cm²). For compressive strength, SMBs have a value of 4.1 N/m², which is slightly higher than conventional bricks (3.1 N/m²) and fly ash bricks (3.5 N/m²), and comparable to ACC bricks (4.5 N/m²) and aircrete bricks (4.2 N/m²), but slightly lower than FRC and plastic waste bricks, which have the highest values at 4.2-4.8 N/m². In terms of thermal insulation, Redone provides 2-2.5 m²•K/W, making them more insulating than SMBs bricks (0.5-1.9 m²•K/W), similar to conventional bricks (1-1.7 m²•K/W), even it also beats aircrete bricks (1.8-2.2 m²•K/W) or plastic waste bricks, which offer insulation (1.5-2.0 m²•K/W). Regarding water absorption, Redone absorbs 20% of water compared to regular bricks, which is significantly lower than SMBs (80%), conventional bricks (60%), and fly ash bricks (75%). However, ACC bricks (40%), ,FRC bricks (25%), plastic waste bricks (5%), and aircrete bricks (32%) show even better resistance to water absorption. Finally, in terms of cost-effectiveness, Redone is priced at 8 INR/cm³, making them the most cost-effective option compared to SMBs (15 INR/ cm³), conventional bricks (23 INR/cm³), fly ash bricks (18 INR/cm³), ACC bricks (29 INR/cm³), and FRC bricks (29 INR/cm³). Only plastic waste bricks (10 INR/cm³) come close in cost efficiency, while the least economical option is aircrete bricks at 40 INR/cm³.
The comparison of the redone bricks with other materials are is as follows:

Redone Bricks vs. Conventional Bricks
Conventional bricks are strong but often lack the flexibility and resistance to cracking seen in Redone bricks. The traditional kiln-fired method for conventional bricks leads to high energy consumption and a larger carbon footprint. In contrast, Redone bricks demonstrate superior impact resistance. In an experiment, Redone bricks remained intact after being thrown from 2 meters, whereas conventional bricks broke in the first attempt. Conventional bricks require significant raw materials (clay) and energy for firing, contributing to environmental degradation. Redone bricks, being made from waste materials like plastic, fly ash, and C&D debris, significantly reduce environmental impact.

Redone Bricks vs. Stabilized Mud Blocks (SMBs)
Strength and Durability: Redone bricks outperform SMBs in terms of compression strength and impact resistance. SMBs, while strong, often face issues with cracking and shrinkage during the curing process, especially if exposed to moisture. On the other hand, Redone bricks, particularly those made with fly ash and aluminum powder, show higher durability and can withstand impact tests, remaining unbroken after multiple drops from a height of 2 meters.

Sustainability: Both SMBs and Redone bricks utilize locally sourced materials, making them sustainable. However, Redone bricks have a more significant environmental impact reduction by incorporating waste products such as C&D debris, fly ash, and plastic fibers.

Redone Bricks vs. Conventional Bricks
Strength: Conventional bricks are strong but often lack the flexibility and resistance to cracking seen in Redone bricks. The traditional kiln-fired method for conventional bricks leads to high energy consumption and a larger carbon footprint. In contrast, Redone bricks demonstrate superior impact resistance. In an experiment, Redone bricks remained intact after being thrown from 2 meters, whereas conventional bricks broke in the first attempt.

Environmental Impact: Conventional bricks require significant raw materials (clay) and energy for firing, contributing to environmental degradation. Redone bricks, being made from waste materials like plastic, fly ash, and C&D debris, significantly reduce environmental impact.

Redone Bricks vs. Fly Ash Bricks
Strength: Both Redone bricks and Fly Ash bricks utilize fly ash, but Redone bricks outperform Fly Ash bricks in terms of shrinkage and cracking. While Fly Ash bricks generally offer a durable, lightweight alternative, Redone bricks show better structural integrity and less shrinkage, particularly when aluminum powder and plastic waste are incorporated. Additionally, in terms of cost-effectiveness,

Cost: Ffly aAsh bricks require specialized bonding agents and higher processing costs. Redone bricks do not need bonding chemicals, reducing the overall cost, and instead use cost-effective solutions such as plastic fibers and aluminum powder, which contribute to the bricks' strength.

Redone Bricks vs. AAC (Autoclaved Aerated Concrete) Blocks

Impact Resistance: AAC blocks, although lightweight, have lower impact resistance. Redone bricks performed better in an experiment where they were thrown from a height of 2 meters. While AAC blocks broke on the first attempt, Redone bricks remained intact after multiple trials, showcasing their superior durability and resilience.

Production Process: AAC blocks are produced using an autoclaveing, which involves high energy consumption and industrial infrastructure. In contrast, Redone bricks can be produced using simpler, low-energy techniques such as sun-drying or kiln drying, which is more energy-efficient and environmentally friendly.

Redone Bricks vs. FRC (Fiber Reinforced Concrete) Blocks

Durability: FRC blocks are reinforced with fibers to improve tensile strength. However, Redone bricks, particularly those containing plastic fiber reinforcement, outperform FRC blocks in terms of impact resistance. Additionally, the process of molding and drying Redone bricks can be controlled to avoid issues with shrinkage, which is a challenge with FRC blocks.

Weight: While FRC blocks are relatively heavy, Redone bricks are lighter, thanks to the inclusion of aluminum powder and plastic waste. This makes Redone bricks easier to handle during construction, contributing to reduced labor costs and handling time.

Redone Bricks vs. Bricks from Plastic Waste

Impact Resistance: Bricks made from plastic waste are often lightweight but lack the strength and durability required for load-bearing applications. Redone bricks, which incorporate plastic waste, not only benefit from reduced weight but also show better strength and resistance to cracking compared to pure plastic waste-based bricks.

Recycling Effectiveness: Both Redone bricks and plastic waste bricks contribute to reducing plastic waste, but Redone bricks combine plastic with other sustainable materials like fly ash and C&D debris, making them more resource-efficient and robust.

Redone Bricks vs. Aircrete Bricks

Strength and Durability: Aircrete bricks are lightweight and often used for insulation purposes. However, they tend to suffer from brittleness and can break easily under stress. Redone bricks, in contrast, have better impact resistance, demonstrated by their ability to remain intact when thrown from a height of 2 meters. The unique mix of fly ash, aluminum powder, and plastic waste in Redone bricks ensures greater structural integrity than aircrete.

Production Cost and Process: Aircrete bricks require the use of foam and autoclaving, which can increase production costs. Redone bricks are produced with minimal energy consumption, using simpler methods like sun-drying and molding, making them more cost-effective.

IV. REDUCTION IN CARBON FOOTPRINT

As per equation 2, the total CO2 emission for redone bricks is 2.0626 kg/CO2 per kg of redone bricks.

Table 5: CO2 emissions comparisons of Redone bricks with other alternative bricks

Material	CO_2 (kg/kg)	% Reduction vs Redone Bricks
Redone Bricks	2.0626	–
Fired Clay Bricks	0.335	83.76%
AAC Blocks	0.23	88.85%
SMBs	0.48	76.73%
FCBs (avg est.)	0.205	90.06%
Plastic Bricks	0.48	76.73%
Fly Ash	0.0228	98.89%

A comparative analysis of CO2 emissions of the redone bricks with alternative materials as per equation 3, yielded the results in Table 5, which suggests that redone bricks are a significant greener alternative for other materials.

V. CONCLUSION

In this study, Redone bricks have been developed, which serve as a superior alternative to conventional building materials, combining strength, cost-effectiveness, and sustainability. It has a density of 1100 kg/m3, a compressive strength of 4.3 N/M2, a water absorption rate of 20%, and thermal insulation of 2-2.5 m2.K/W. These bricks can be made available at an affordable cost of INR 8. Unlike traditional bricks, redone bricks utilize low-energy production methods, significantly lowering their environmental impact. Also, Redone Bricks emerge as a much greener alternative when compared to conventional materials such as fired clay bricks (0.335 kg CO_2/kg), AAC blocks (0.23 kg CO_2/kg), SMBs (0.48 kg CO_2/kg), or even fly ash bricks (0.205 kg CO_2/kg). With a remarkably low carbon footprint of just 0.00206 kg CO_2 per kg, Redone Bricks achieve over 99% reduction in emissions compared to some widely used materials. This impressive figure is largely due to their innovative use of waste-derived inputs—including construction debris, fly ash, lime, mud, and agricultural waste—rather than relying on energy-intensive raw materials. In doing so, they not only minimize embodied carbon but also promote circularity, resource efficiency, and waste valorization, making them one of the most sustainable building materials available today.

Their innovative composition and eco-friendly processing make them a strong candidate for sustainable construction. By addressing the limits of conventional materials, Redone bricks offer a durable, affordable, and environmentally responsible solution for modern building needs, contributing to a greener and more efficient construction industry.

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