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Development of ECO Friendly Composite Tiles Using Rubber Scrap and Agricultural Waste

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Abstract - In recent years, the growing concern over the improper disposal of rubber waste, particularly discarded vehicle tires, has led to an urgent demand for innovative and sustainable recycling solutions. This project aims to manufacture eco-friendly rubber flooring tiles by utilizing crumb rubber, rice husk ash (RHA), natural latex and polyurethane as primary materials. The crumb rubber sourced from waste tires, serves as the core material, while RHA enhances the mechanical strength due to its high silica content. Polyurethane is used as a binding agent similarly the natural latex is to ensure durability and flexibility. The proposed tiles are not only cost-effective and weather-resistant but also contribute to environmental protection by reducing non-biodegradable rubber waste.This project supports the principles of the circular economy by transforming industrial and agricultural waste into value-added construction materials. The outcome presents a sustainable alternative for pavements, walkways and cost effective flooring applications, thus promoting greener construction practices.

Keywords: Rubber tiles, recycled rubber, rice husk ash, polyurethane, natural latex, compression moulding, heating press, sustainable flooring, eco-friendly materials, waste utilization.

I. Introduction

With the rapid rise in urbanization and transportation, rubber waste especially from discarded tires has become a serious environmental concern. India alone contributes about 150 million waste tires annually, which are non-biodegradable and harmful when improperly disposed[1]. This work aims to create eco-friendly rubber tiles using crumb rubber, rice husk ash, natural latex and polyurethane resin[3]-[5]. These tiles offer a sustainable, durable and cost-effective alternative to traditional flooring, supporting circular economy goals and promoting greener construction practices[4]-[6].

II. Material Used and Properties

A. Rubber crumb.

Fig 1. Rubber crumb

In this project, 40 mesh crumb rubber obtained by grinding waste tires into fine particles is used as a key component. This size ensures better bonding with materials like rice husk ash, natural latex and polyurethane resin. 40 mesh crumb rubber retains essential properties such as high elasticity, good tensile strength, low thermal conductivity and excellent impact absorption, making it ideal for durable and eco-friendly flooring application.

Table 1. Properties of Rubber crumb.

S. No	Properties	Details
1.	Density	0.9 – 1.2 g/cm³
2.	Tensile strength	1 – 2 MPa
3.	Thermal resistance	Strong
4.	Slip resistance	High
5.	Chemical resistance	Moderate

B. Rice husk ash.

Fig. 2. Rice husk ash

Rice husk ash (RHA) is a fine grey powder obtained through the controlled combustion of rice husk, an agricultural by product. It is rich in amorphous silica, giving it excellent pozzolanic properties. Due to its lightweight nature, fine particle size and good thermal and chemical resistance, RHA is widely used as a sustainable additive in composite materials. In this project, RHA enhances the strength, durability and eco friendliness of rubber based tiles and it is acting as best filler for our tiles.

Table 2. Properties of Rice husk ash.

S.No.	Properties	Details
1.	Pozzolanic Activity	High
2.	Bulk density	0.3 to 0.6 g/cm³
3.	Thermal Stability	Stable up to ~800°C
4.	Chemical Resistance	High
5.	Fine Particle Size	Around 150 microns fills voids

C. Polyurethane:

Fig. 3 Polyurethane

Polyurethane resin is a two-component thermosetting polymer formed by the reaction of polyol and isocyanate. It has a density of 1.0 to 1.2 g/cm³ and cures at room temperature without the need for external catalysts. Known for its high mechanical strength, excellent flexibility, strong adhesion, resistance to water, chemicals and UV rays it is ideal for both indoor and outdoor applications.

Table 3. Properties of Polyurethane

S.No.	properties	Details
1.	Density	1.0 to 1.2 g/cm³
2.	Mechanical Strength	High
3.	Elongation at Break	Moderate to High (~100–300%)

D. Natural latex.

Natural latex is a milky fluid extracted from the rubber tree Hevea brasiliensis. It is a renewable and eco-friendly material known for its elasticity, water resistance and natural adhesive properties. Composed mainly of water and rubber hydrocarbons (polyisoprene), it also contains proteins, resins, sugars and minerals that enhance its performance.

Fig. 4 Natural latex

Table 4. Properties of Natural latex

S.No	Properties	Details
1.	Elasticity	High
2.	Water resistance	High
3.	Adhesive properties	Good
4.	Thermal stability	Moderate to high

E. Iron Oxide

Iron oxide is a naturally occurring inorganic compound widely used as a pigment due to its excellent coloring properties. It is available in various shades such as red, yellow, brown and black, depending on its oxidation state. In construction, iron oxide is commonly added to rubber tiles and concrete products to enhance their aesthetic appeal without affecting their strength or durability. It is UV-stable, non-toxic and resistant to fading, making it a sustainable and long-lasting coloring agent.

F. Manual Compression Machine

We designed the **Manual Compression Machine** is a cost-effective and sustainable setup for small-scale or prototype production of rubber tiles using recycled materials. It consists of a sturdy iron frame that holds a tile mould, heating plates and a manually operated lead screw.

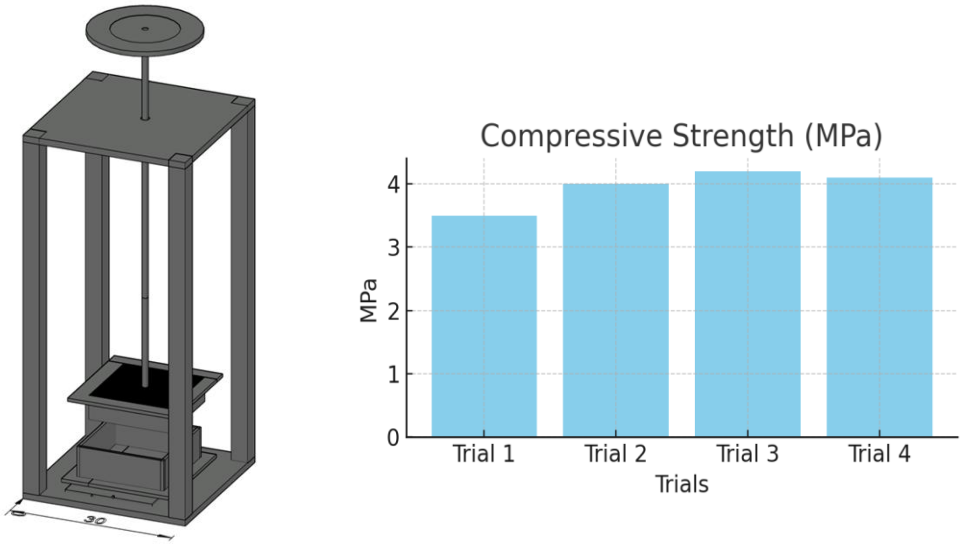


Fig. 5 Manual compression machine

The primary function of this machine is to apply uniform pressure and heat to the rubber mixture composed of rubber crumb, rice husk ash and a binder to form durable tiles. The top and bottom plates (30 × 30 × 0.5 cm) are made of mild steel to endure compressive forces, while heating plates maintain a curing temperature between 140–150°C.

During operation, the rubber mixture is filled into the mould, heated and compressed using the lead screw, ensuring even bonding and shaping. After 10–15 minutes of curing, the tile is demoulded and allowed to cool for 24–48 hours to gain strength.

This machine provides an eco-friendly alternative in construction by turning waste rubber into useful flooring products.

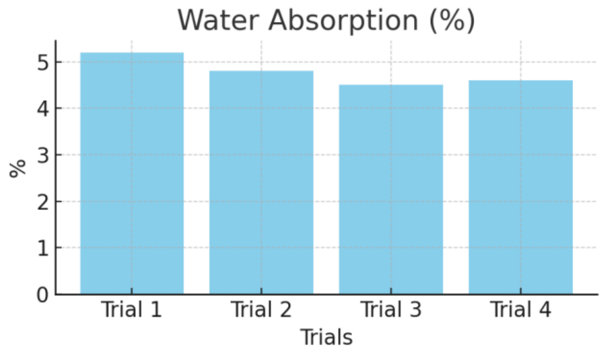
III. Results and Discussion

A. Compressive strength test on Rubber tiles.

The compressive strength test was conducted to evaluate the tile's ability to withstand load without failure. Across four trials, the values gradually increased from 6.2 N/mm² to 7.0 N/mm². The final achieved value of 7.0 N/mm² meets the desired strength typically expected in non-structural rubber flooring applications. This indicates that the tile possesses sufficient compressive resistance for general use, ensuring durability under foot traffic and moderate loads.

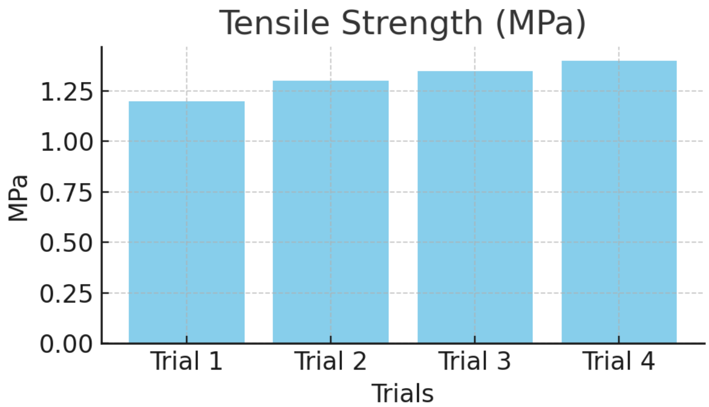
B. Tensile strength test

The tensile strength test assessed the tile's resistance to pulling or stretching forces. Trial values progressed from 1.1 MPa to a final result of 1.5 MPa, which is suitable for rubber products made from recycled materials. Achieving 1.5 MPa demonstrates that the tile has acceptable elasticity and mechanical integrity, contributing to its long-term performance in real-world usage.



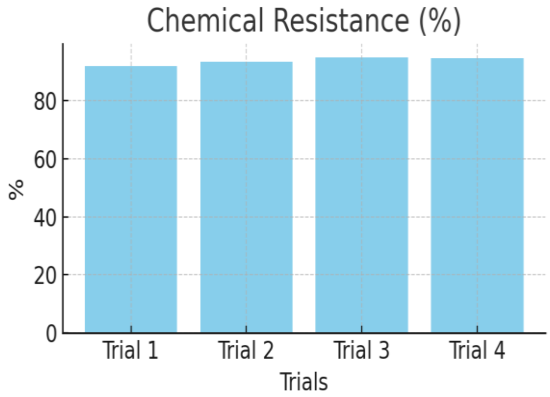
C. Water absorption test

Water absorption was evaluated to determine the tile's porosity and suitability for moisture-prone environments. The water absorption percentage reduced from 6.5% in the first trial to 5.5% in the final trial. Since values below 10% are generally preferred for outdoor and wet applications, this result confirms the tile's resistance to excessive moisture absorption, thus enhancing its durability and longevity.



D. Chemical resistance test.

The chemical resistance test evaluated the rubber tile's ability to withstand mild chemical exposure by measuring weight loss. The weight loss percentage showed a consistent decrease across trials, from 3.5% to 2.2%. The final result of 2.2% weight loss indicates **excellent chemical stability**, demonstrating that the tile is highly resistant to degradation in chemical environments. This makes it suitable for applications such as laboratories, industrial flooring and kitchens where chemical contact is expected.



IV. Conclusion

This project demonstrated the design, fabrication and application of a manually operated compression machine for the sustainable production of rubber tiles using recycled materials such as rubber crumb and rice husk ash.

The machine was simple, cost-effective and suitable for small-scale or prototype manufacturing. Through a series of four trials, rubber tiles were produced and tested for compressive strength, tensile strength, water absorption and chemical resistance.

The final mix achieved desired performance across all tests, proving the efficiency of the selected materials and the reliability of the manual compression process.

This project supports the growing need for sustainable construction materials and highlights an innovative approach to waste management by converting rubber waste into durable and eco-friendly flooring solutions.

These findings suggest that PU is a more reliable binder for manufacturing durable, flexible and chemically stable rubber tiles. Thus, PU rubber tiles are well-suited for use in industrial floors, laboratories, kitchens and high-traffic zones where both mechanical strength and chemical resistance are critical.

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