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Visvesvaraya Technological University Belagavi,
Karnataka – 590 018

A PROJECT REPORT
On

"WASTE PLASTIC REINFORCED CONCRETE BRICK"

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By

HARSHITH	**4MT19ME005**
PRAVEEN SURYAKANTH	**4MT19ME023**
RAJPRASAD N ACHARYA	**4MT19ME025**
STEPHAN SERRAO	**4MT19ME035**

Under the Guidance of

Mr. Sridhar D R
Senior Asst. Professor,
Department of Mechanical Engineering

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MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING
(An ISO 9001: 2015 Certified Institution)
(Affiliated to Visvesvaraya Technological University Belagavi)
Budgerigar, Moodbidri-574225, Karnataka

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Abstract

The rapid accumulation of waste plastic has become a significant environmental concern, necessitating innovative solutions for its effective management. This abstract presents a sustainable approach that addresses this issue by incorporating waste plastic into the production of reinforced concrete bricks. These bricks offer numerous advantages, including enhanced structural strength, reduced environmental impact, and efficient waste utilization. The research explores various methods of incorporating waste plastic into the concrete mix, such as shredded plastic fibers or granules, while maintaining the required material properties. The inclusion of waste plastic enhances the tensile strength and durability of the bricks, making them suitable for construction applications. The study investigates the mechanical properties, such as compressive strength, flexural strength, and water absorption capacity, to assess the performance of the waste plastic reinforced concrete bricks. Additionally, the environmental impact of the bricks is valuated through life cycle assessments, comparing them to conventional concrete bricks. The findings demonstrate that waste plastic reinforced concrete bricks exhibit favorable mechanical properties and reduced carbon footprint, making them a sustainable alternative for construction. This research contributes to the advancement of eco-friendly building materials and supports the circular economy by repurposing waste plastic in construction applications.

Keywords: waste plastic, reinforced concrete, bricks, sustainability, construction.

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1. INTRODUCTION

Humans utilize water for a variety of purposes, but the purity of the water they consume is critical since it has a direct impact on their health. Access to clean and safe water is a serious issue in many poor countries. According to the United Nations, 1.1 billion people still lack access to safe drinking water, and these people are among the poorest in the world. Poor water quality is a major contributor to poor livelihood and health in impoverished countries, accounting for 80 percent of all diseases (OECD, 2006). Because there are few other options, surface water from rivers or rain-fed ponds has become one of the most important sources of water.

This water is susceptible to contamination from a variety of sources, the most prevalent of which being dwellings, agriculture, and businesses. Moringa oleifera is a Moringaceae plant. Its seeds have been demonstrated to be one of the most effective bio-coagulants for water treatment, including turbidity, alkalis, organic pollutants via BOD, COD, and industrial effluent. Many investigations have been carried out to identify the key causes of dangerous decrease. Because of the constancy of the antioxidants and antibacterial, it is also capable of destroying microbes.

In the wastewater treatment process, the main processes are coagulation, followed by coagulation. Aggregation are physicochemical processes and are often used at the beginning or end of a wastewater treatment process. Water that contains disease-causing organisms is not important for water purification technologies, some of which are more effective at removing some impurities, including carbon adsorption, ion exchange, distillation, and filtration, but require different amounts of energy and water. This is true even though ion exchange is very effective at removing organic contaminants from water, and carbon adsorption removes suspended solids from water with a 99 percent efficiency rate, when being reversed, it creates high-quality water containing bacteria.

2. OBJECTIVES

- To assess the reduction in cost due to the integration of plastic waste in conventional brick, aiming to identify potential cost-saving measures in construction materials.
- To explore the viability of utilizing plastic waste in construction materials, with the goal of promoting sustainable practices and reducing environmental impact.
- To evaluate the mechanical properties of the brick, such as compression strength and load-bearing capacity, to determine its suitability for use in the construction field.
- To assess the thermal properties of the brick, including its resistance to fire and heat, to ensure its suitability for various environmental conditions and potential applications.
- To analyze the durability and longevity of the brick, considering factors such as water absorption rate and resistance to moisture penetration, in order to ensure its long-term performance and suitability for construction projects.

3. METHODOLOGY

➢ Flow Chart of methodology

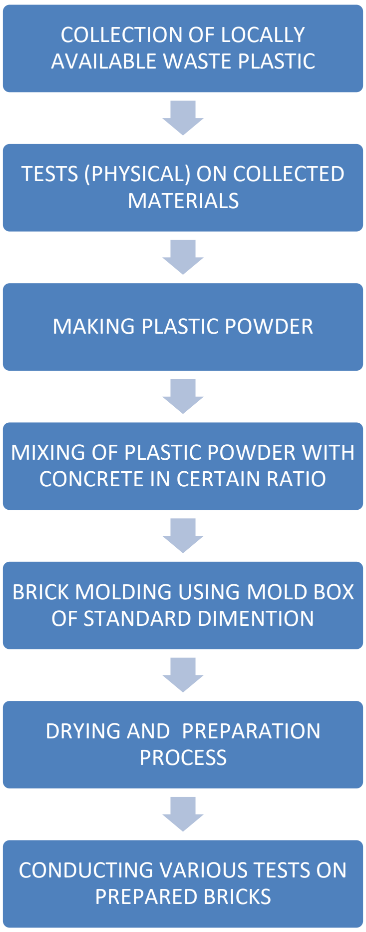

Fig 4.1: Process Flow chart

➢ Process of Casting Plastic Reinforced Concrete Brick

1. Collect waste plastic materials from local sources, such as plastic bags, bottles, or containers. Ensure that the collected plastic is clean and free from any contaminants.
2. Tests (Physical) on collected materials: Conduct physical tests on the collected plastic materials to determine their properties, such as tensile strength, flexibility, hardness, and impact resistance. This information will help in determining the appropriate ratio of plastic powder to be used in the concrete mix.

3. Once the plastic materials are collected, they need to be converted into a powdered form. This can be done by shredding or grinding the plastic materials using appropriate equipment. The resulting plastic powder should be of a consistent size and texture.
4. Determine the appropriate ratio of plastic powder to be added to the concrete mix based on the physical test results and desired properties of the final bricks. Mix the plastic powder with the concrete in a predetermined ratio, typically by weight or volume. Thoroughly blend the materials to ensure uniform distribution of plastic powder in the concrete mix.
5. Prepare a mold box of standard dimensions for the brick size desired. Place the mixed concrete with plastic powder into the mold box and compact it using appropriate techniques, such as vibrating or pressing, to achieve proper compaction and eliminate air voids.
6. Allow the molded bricks to cure and dry for a specific period of time, typically under controlled environmental conditions. This will ensure proper setting and hardening of the concrete. After drying, carefully remove the bricks from the mold box and stack them for further curing, if required.
7. Once the bricks are cured and dried, conduct various tests to evaluate their properties, such as compressive strength, water absorption, and durability. Compare the test results with standard specifications for bricks to assess the quality and performance of the waste plastic reinforced concrete bricks.

➢ Fixing the proportion of Sand and Plastic in Concrete

For the fabrication of plastic Reinforced concrete bricks, sand is replaced with plastic in different proportions in the concrete mixture and bricks containing different proportions of plastic and sand are made. In the concrete composition sand is replaced with Plastic powder by 25%, 50% and 100%.

The reason behind taking different proportions of plastic and sand is to find the optimum proportion which gives the desired results. The bricks made of these ratios will further be investigated for various desired properties.

➢ Collection of Materials

The process of collecting waste plastic materials involves several steps. First, designated collection points are set up in residential areas, commercial establishments, and public spaces. People are encouraged to segregate their plastic waste and deposit it in these collection points. Local waste management authorities then collect the accumulated plastic waste regularly and transport it to recycling centers. Recycling companies and facilities sort and categorize the plastic based on its type and quality. The sorted plastic is then processed through shredding machines to reduce it into small flakes, which can be used as raw material for various recycling processes, including the production of waste plastic reinforced concrete bricks.

Fig 1: Plastic waste collection

Fig 2: PVC waste

➢ Tests on the collected material

Collected waste plastic materials undergo a series of tests to assess their suitability for recycling and specific applications. These tests typically include visual inspection, density measurement, melting point determination, thermal stability assessment, and mechanical property evaluation. Visual inspection ensures the absence of contaminants, such as non-plastic items or chemical residue. Density measurement helps identify different plastic types. Melting point determination ensures compatibility during processing. Thermal stability assessment examines the plastic's behavior under heat. Mechanical property evaluation checks for tensile strength, flexibility, and impact resistance. These tests provide crucial data for determining the appropriate recycling processes and applications for the collected waste plastic materials, including their use as reinforcement in concrete bricks.

➢ Making Plastic Powder

To convert waste plastic into plastic powder for mixing in concrete to prepare plastic reinforced concrete bricks, an angle grinder mechanism can be used. The waste plastic is first cleaned and dried to remove any contaminants. Then, it is fed into the angle grinder equipped with appropriate grinding attachments or blades. The grinder effectively grinds the plastic waste into fine particles or powder. This plastic powder can then be mixed with the concrete mixture during the preparation of plastic reinforced concrete bricks, ensuring a uniform distribution of plastic reinforcement throughout the concrete matrix, enhancing its strength and durability. Care should be taken to use proper safety precautions while operating the angle grinder.

Fig 3: Grinding

Fig 4: Plastic Powder

➢ Mixing Plastic Powder with Concrete in Certain ratio

When There are different types of materials used for the manufacture of plastic brick are,

- **Cement**

Cement, a fundamental material in the construction sector, serves as a binder in the production of concrete, which is extensively utilized in global construction projects. The origins of cement production can be traced back to ancient times, with the utilization of lime-based cement as early as 700 BC. However, modern cement production commenced in the 19th century with the invention of Portland cement, the most widely used type of cement today.

Fig 5: Cement

The process of cement manufacturing typically involves clinker production, wherein raw materials like limestone, clay, shale, and silica are quarried, crushed, and blended with small quantities of additional materials, such as gypsum, to create a homogeneous powder. This powder is then subjected to high temperatures of up to 1450°C in a kiln, resulting in the formation of clinker. Subsequently, the clinker is finely ground to produce cement, which is utilized in construction. Cement is renowned for its exceptional binding properties, enabling it to solidify and harden upon mixing with water to create concrete. Concrete, which is made by combining cement with aggregates (such as sand and gravel) and water, finds wide-ranging applications in construction, including foundations, roads, bridges, dams, and more. Cement imparts strength, durability, and versatility to concrete, rendering it an indispensable component of contemporary construction practices.

However, cement production is associated with environmental concerns, such as carbon emissions from fossil fuel combustion in kilns, as well as potential impacts on land and water resources due to quarrying and mining. In recent years, concerted efforts have been undertaken to develop sustainable and eco-friendly cement production methods, including the utilization of alternative raw materials, optimization of kiln processes, and exploration of carbon capture and utilization technologies.

In conclusion, cement plays a pivotal role in the construction industry by providing crucial binding properties for the production of durable and versatile concrete. While environmental challenges persist, ongoing research and development endeavors in cement production aim to mitigate the impacts and promote sustainable practices for the future of construction.

- **Gravel**

Gravel, which comprises small, rounded rocks or pebbles and falls in size between sand and cobblestones, ranging from 2mm to 75mm in diameter, is a granular material. It exhibits a range of colors and textures, influenced by the type of rocks from which it originates. Due to its durability, excellent drainage properties, and versatility, gravel is widely utilized in construction, landscaping, and road building. Its interlocking characteristics make it ideal for creating stable foundations, road bases, and pathways. Moreover, gravel is commonly employed in decorative applications, such as in gardens, driveways, and pathways, owing to its aesthetic appeal and ability to enhance outdoor spaces. Gravel is often graded based on size, shape, and quality, catering to specific uses. It is a readily available natural resource that serves as a valuable asset to various industries worldwide. Regulations are in place for gravel extraction and production to mitigate environmental impacts, such as habitat disruption and erosion.

Fig 6: Gravel

In summary, gravel is a versatile material with extensive utilization in construction, landscaping, road building, and decorative applications. Its durability, drainage properties, and availability make it a valuable resource across various industries, contributing to infrastructure development and the enhancement of outdoor spaces.

- **Plastic**

Plastic, being a man-made material, presents numerous environmental challenges due to its non-biodegradable nature. Despite its wide-ranging applications driven by its durability and low-cost production, plastic persists in the environment for extended periods, resulting in pollution and detrimental effects on wildlife. The accumulation of plastic waste, including single-use items like straws and plastic bags, in landfills and oceans leads to habitat destruction, water pollution, and threats to marine life. Moreover, plastic production contributes to greenhouse gas emissions and relies on fossil fuels, exacerbating climate change. To address the issues associated with plastic pollution, it is imperative to focus on reducing plastic consumption, improving waste management, promoting recycling and sustainable alternatives, and raising awareness about the detrimental impacts of plastic on the environment.

Fig 7: Plastic Granuels

- **Sand**

The composition of sand is highly diverse, consisting of various rocks and minerals, resulting in differences in its chemical properties. The predominant component of sand is typically quartz, which is primarily composed of silicon oxide. In terms of physical characteristics, sand is comprised of small, loosely packed grains that are larger than silt but smaller than gravel.

Fig 8: Sand

Sand is categorized as a granular material composed of finely divided particles derived from rocks and minerals. It is differentiated by its size, falling between the coarser texture of gravel and the finer texture of silt. Additionally, sand can refer to a specific textural class of soil that contains more than 85 percent of sand-sized particles by mass. Silica, specifically in the form of quartz, is the most common constituent of sand, although the composition may vary depending on the local sources and environmental conditions. Notably, sand is considered a non-renewable resource on human timescales, and the demand for sand suitable for concrete production is high.

In accordance with Indian standards set by IS, the collection and utilization of sand for concrete typically involves using sand that passes through a 4.75mm sieve. River sand is commonly employed for paving purposes.

- **Mixing**

The process involves replacing a portion of the sand in the concrete mixture with plastic powder. In the original concrete mixture, which consists of gravel, sand, and cement in a ratio of 4:2:1, the sand component is modified. Depending on the desired ratio, sand is replaced by plastic powder in percentages of 25%, 50%, or 100%. This means that for a 25% replacement, 25% of the sand quantity is substituted with plastic powder, and so on. The plastic powder is thoroughly mixed with the remaining components of the concrete mixture, namely gravel and cement, to achieve a uniform distribution. This alteration aims to utilize waste plastic and enhance the sustainability of the concrete composition.

Fig 9: Mixing

Table 1 : Composition of Gravel, Sand, Plastic and Cement

Types of Bricks	Gravel Ratio	Sand Ratio	Plastic Ratio	Cement Ratio
Brick 1	4	2	0	1
Brick 2	4	1	1	1
Brick 3	4	0	2	1

➢ Brick Moulding Using Standard Mould Box

The construction of a mold box with standard dimensions of 190 x 90 x 90 (in mm) involves the following steps. First, gather materials such as plywood or any other sturdy material. Cut six pieces of the material to the specified dimensions: two side pieces measuring 190 x 90 (in mm) , two end pieces measuring 90 x 90 (in mm), and two base pieces measuring 190 x 90 (in mm). Assemble the pieces by securely joining them using nails, screws, or adhesive. Ensure that the corners are properly aligned and reinforced. The resulting mold box provides a framework to contain the plastic reinforced concrete mixture during the curing process, allowing the formation of bricks or blocks with the desired dimensions.

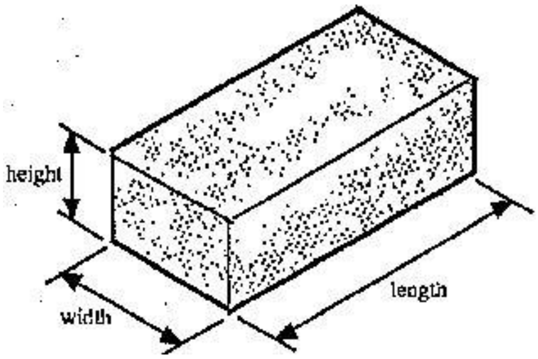

Fig 10: Brick Dimension

Fig 11: Mould Box

Fig 12: Brick Moulding

➢ Final Product

Plastic reinforced concrete bricks are the final product obtained after the preparation and curing process. These bricks are composed of a mixture of cement, sand, aggregate, and a certain percentage of plastic Powder. The plastic reinforcement enhances the mechanical properties of the concrete, making the bricks more durable and resistant to cracking. The final product exhibits good compressive strength, flexural strength, and water absorption properties. Plastic reinforced concrete bricks offer an eco-friendly alternative to traditional bricks, as they utilize waste plastic materials. These bricks can be used in various construction applications, providing a sustainable solution while reducing plastic waste.

Fig 13: Final Product

Fig 14: Bricks with different Plastic composition

4. EXPERIMENTATION

Experimentation on plastic reinforced concrete bricks involves testing the performance and properties of these bricks under various conditions. The bricks are subjected to tests such as compressive strength, water absorption, Fire Resistance Test, density, and durability assessments. These tests evaluate the structural integrity, load-bearing capacity, resistance to cracking, and durability of the plastic reinforced concrete bricks. Additionally, experiments may involve assessing the effects of different plastic ratios, types of plastic, curing methods, and environmental factors on the properties of the bricks. The results of these experiments help optimize the composition and production process of plastic reinforced concrete bricks for sustainable and effective use in construction applications.

➢ Tests on Bricks

In the project report, several tests were conducted on plastic reinforced concrete bricks to assess their performance and properties. The tests included compressive strength, flexural strength, water absorption, density, and durability assessments. Compressive strength tests were performed to determine the maximum load the bricks could withstand. Flexural strength tests assessed their resistance to bending and cracking. Water absorption tests evaluated the bricks' ability to resist moisture penetration. Density tests measured their mass per unit volume. Durability assessments examined the bricks' resistance to weathering, freeze-thaw cycles, and chemical exposure. These tests provided valuable data for evaluating the structural integrity and suitability of plastic reinforced concrete bricks for construction applications.

• 5.1.1 Compression Strength Test

The compression test is a crucial test performed on plastic reinforced concrete bricks to evaluate their strength and load-bearing capacity. In this test, a plastic reinforced concrete brick specimen is subjected to a gradually increasing compressive force until it reaches failure. The maximum force it withstands before failure is recorded as the compressive strength. This test helps assess the structural integrity and ability of the brick to resist crushing under axial loads.

Fig 15: Compression test in UTM

Fig 16: Crack point

The results of the compression test provide valuable data for the project report, allowing for comparisons between different mixtures, plastic ratios, and curing methods, and determining the suitability of plastic reinforced concrete bricks for specific construction applications.

COMPRESIVE STRENGTH= MAXIMUM LOAD APPLIED SPECIMEN AREA

COMPRESSIVE STRENGTH = F/A

Where,

F - Maximum load applied (KN)

A – Specimen Area (mm2)

Table 2 : Compresssion Test

Type of Brick Gravel:Sand:Plastic:Cement) (G:S:P:C)	Maximum Load (kN)	Compressive Strength (Kg/mm^2)
Brick 1 (4:2:0:1)	500	37.86
Brick 2 (4:1:1:1)	525	46.92
Brick 2 (4:0:2:1)	460	34.24

- **Water Absorption Test**

In this test at first the bricks are weighed in total dry conditions. Then they will be allowed to be dipped in fresh water for about 24 hours in a container. The bricks are taken out of the water after 24 hours and are wiped with a cloth. The wet brick is weighed using a weighing machine. For the calculation of water absorption, the difference between wet brick and dry brick is done. The difference is the amount of water absorbed by the brick. After that the percentage of water absorption is calculated using the data. Water absorption of bricks tells about the bonding of bricks with mortar. Although other factors such as grooves and design on bricks also improve the bonding. For Plastic Reinforced Concrete bricks which have less water absorptivity leaner mortar layer is used for Concrete Bricks and mortar. Greater quality bricks absorb less amount of water. For a good quality brick, the water absorption should be less than 20% of its own weight.

Fig 17: Water Absorption Test

Fig 18: Bricks immersed in water for 24 hours

WATER ABSORPTION =

[{ WEIGHT OF WET BRICK – WEIGHT OF DRY BRICK } / WEIGHT OF DRY BRICK] * 100

Table 3: Water Absorption Test Test

Type of Brick (G:S:P:C)	Weight W1 (kg)	Weight W2 (kg)	Water Absorption (%)
Brick 1 (4:2:0:1)	3.61	3.77	4.3
Brick 2 (4:1:1:1)	3.578	3.60	0.62
Brick 2 (4:0:2:1)	3.53	3.550	0.56

- **Fire Resistance Test**

The standard used for the test is BIS 3809 1979. The plastic alone is readily susceptible if not flammable to elevated temperatures and in case of fire, the sand and plastic mixture may withstand temperatures that plastics alone usually cannot. It has been observed that the structural integrity of the bricks holds very well up to 180^{o} C. In this test we will first heat and maintain the brick at the standard testing temperature in the furnace and then we will do the compressive strength test to check whether the properties change or not.

Fig 19: Fire Resistance Test

5. RESULTS AND CONCLUSION

➢ Result

A The utilization of waste plastic in reinforced concrete bricks has gained significant attention due to its potential environmental and economic benefits. These bricks are produced by incorporating shredded plastic waste into the concrete mixture, acting as a partial replacement for traditional aggregates. The result is a composite material that exhibits improved strength, reduced density, and enhanced thermal insulation properties compared to conventional concrete.

The incorporation of waste plastic in concrete bricks offers several advantages. Firstly, it reduces the consumption of natural resources by utilizing plastic waste that would otherwise end up in landfills or pollute the environment. Additionally, the lighter weight of these bricks makes them easier to handle during construction, reducing labor and transportation costs. Moreover, the improved thermal insulation properties contribute to energy efficiency in buildings by reducing the need for heating and cooling.However, the use of waste plastic in concrete bricks also poses some challenges. The compatibility of plastic waste with the concrete mixture, including the type and quantity of plastic, requires careful consideration to ensure optimal performance. The long-term durability and structural integrity of the bricks must also be thoroughly assessed.

In conclusion, waste plastic reinforced concrete bricks hold great potential for sustainable construction practices. Further research and development are necessary to optimize the manufacturing process, address potential drawbacks, and explore the long-term performance of these bricks. Their adoption could contribute to reducing plastic waste, conserving natural resources, and promoting environmentally friendly building materials.

The study involved the preparation of plastic reinforced concrete bricks with three different compositions. The compositions were adjusted by varying the sand content and incorporating plastic powder in the ratios of 4:2:0:1, 4:1:1:1, and 4:0:2:1 (Gravel: Sand: Plastic powder: Cement). And tests were conducted on these bricks by this we can conclude that,

- The compression strength test results revealed that the brick with the composition ratio of 4:1:1:1 demonstrated the highest compression strength of 46.92 kN/mm^2. This indicates its superior load-bearing capacity and structural integrity compared to the other compositions.
- The water absorption test results indicated that the same brick composition exhibited a water absorption rate of 0.62%. This suggests that it possesses a relatively low permeability and can resist moisture penetration, contributing to its durability and longevity.
- The brick demonstrated excellent fire resistance, maintaining structural integrity up to 180°C, suggesting its suitability for fire-prone environments.-
- The brick with a ratio of 4:1:1:1 offered promising results while being more cost-effective compared to traditional concrete bricks.
- The reduced reliance on sand and incorporation of plastic powder in the composition led to cost savings without compromising the performance and durability of the brick.

Overall, based on the obtained results, the brick with a composition ratio of 4:1:1:1 of Gravel, Sand, Plastic powder, and Cement stands out as the most favorable option among the tested samples. Its superior compression strength, low water absorption rate, and cost-effectiveness make it a promising alternative to traditional concrete bricks.

6. SCOPE FOR FUTURE WORK

- Plastic reinforced concrete bricks have the potential for increased utilization in construction projects, replacing conventional bricks and reducing the demand for natural resources like clay and sand.
- The use of plastic waste as a reinforcement in concrete bricks offers a viable solution for managing plastic waste and reducing environmental pollution.
- Further research can focus on optimizing the composition and production process of plastic reinforced concrete bricks to enhance their durability and resistance to various environmental factors.
- Develop comprehensive guidelines and recommendations for the implementation and adoption of waste plastic reinforced concrete bricks in construction projects. These guidelines should consider engineering standards, construction practices, and regulatory requirements to ensure safe and effective utilization.
- Conduct extensive life cycle assessments comparing the overall environmental impact of waste plastic reinforced concrete bricks with traditional concrete bricks. Consider factors such as energy consumption, emissions, and waste generation throughout the entire life cycle to determine the environmental benefits and feasibility of using waste plastic reinforcement.
- Utilizing plastic reinforced concrete bricks in infrastructure projects, such as roads, bridges, and pavements, can contribute to the development of sustainable and eco-friendly infrastructure systems.
- Establishing standards and certifications specific to plastic reinforced concrete bricks can promote their wider acceptance and integration into building codes and regulations.