UTILIZATION OF PLASTIC WASTE IN MANUFACTURING OF BRICKS

A

PROJECT REPORT

Submitted in partial fulfillment of the requirements for the Degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

Of

Mr. CHANDRA PAL GAUTAM
[ASSISTANT PROFESSOR GRADE-II]

By

LAKSHAY SHARMA [191620]

to

JAYPEE UNIVERSITY OF INFORMATIONTECHNOLOGY, WAKNAGHAT
MAY- 2023

STUDENT'S DECLARATION

We, the undersigned, hereby certify that the project report titled **"UTILIZATION OF PLASTIC WASTE IN MANUFACTURING OF BRICKS" s**ubmitted in partial fulfillment of the requirements for the Bachelor of Technology degree in Civil Engineering at the **Jaypee University of Information Technology, Waknaghat** is a genuine and original piece of work that we completed under the supervision of Mr. Chandra Pal Gautam This project report has not previously been submitted for consideration for any other degree or credential.

We declare that the contents of this project report are entirely our own and that we have taken every precaution to ensure that the information presented is correct and complete. We appreciate our supervisors' and other contributors' help and guidance in completing this project successfully.

In conclusion, we attest to this project report's authenticity, originality, and integrity, and we are confident that it meets the highest academic standards.

Lakshay Sharma (191620)

Department of Civil Engineering

Jaypee University of Information

Technology, Waknaghat

CERTIFICATE

This is to certify that the project report titled **"UTILIZATION OF PLASTIC WASTE IN MANUFACTURING OF BRICKS"** submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat**, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering, is an authentic record of work conducted by Laskshay Sharma (191620) between August 2022 and May 2023, under the supervision of Mr. Chandra Pal Gautam (Assistant Professor, Grade-II), Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

To the best of our knowledge, the preceding statement is correct a true.

Date:

Signature of (HOD)
Dr. Ashish Kumar
Professor and Head
Department of Civil
Engineering
JUIT, Waknaghat

Signature of Supervisor
Mr. Chandra Pal Gautam
Assistant Professor, Grade-II
Department of Civil
Engineering
JUIT, Waknaghat

ACKNOWLEDGEMENT

The completion of this project was made possible by the invaluable guidance and assistance of numerous individuals, and we consider ourselves extremely fortunate to have received such assistance. Their timely support, helpful suggestions, and careful efforts enabled us to present the work embodied in this research in its current form. It has been a privilege to work under their esteemed supervision. We would especially like to thank Prof. (Dr.) Ashish Kumar, Professor and Head, and Mr. Chandra Pal Gautam, Assistant Professor, Grade-II, for their unwavering guidance and supervision throughout the project. We owe our supervisors a great debt of gratitude for their ongoing support and encouragement, and we are extremely grateful for their contributions.

ABSTRACT

The environmental concern of plastic waste (PW) generation has escalated to an alarming level due to the versatility and high demand in various applications. In order to search for an effective way to utilize PW, reusing them for the production of construction material appears as an environmentally-friendly approach. This is also because conventional construction materials often consume high energy during production has caused many environmental impacts. This review paper summaries the previous studies on reusing various PW as raw material and aggregate for construction and its properties with special attention to bricks and paving blocks. This paper begins by illustrating on the properties of plastics and the impacts of PW to the environment. Followed by discussion on reusing PW and its impacts on the overall properties of construction material. This review found that limited studies had been conducted on the usage of PW in the production of the paving block. Besides, most of the studies focused predominantly on compressive strength and water absorption as the main parameters to evaluate the characteristics of bricks and paving blocks. It is concluded that the use of PW in construction material could possibly serve as a sustainable source for construction material in the future.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

General

The utilization of plastic waste in the manufacturing of bricks offers a promising solution to address the environmental challenges associated with plastic waste while providing a sustainable alternative to traditional brick production methods.

In addition to offering a sustainable replacement for conventional brick production techniques, the use of plastic waste in the brick-making process offers a possible solution to the environmental problems related with plastic waste. Brick production often involves the extraction of natural resources, uses a lot of energy, and is a major cause of habitat loss, soil erosion, and greenhouse gas emissions. We may lessen these problems by using plastic waste while making bricks. Plastic waste is broken down into tiny bits as part of the process, and then it is mixed with components used to make traditional bricks, such as cement, sand, and clay. After being formed into bricks, the mixture goes through a curing phase. These plastic bricks have improved qualities that make them suited for a variety of applications, such as better thermal insulation, lighter weight, and increased durability. The utilization of plastic waste in the manufacturing of bricks has gained significant attention as a means to address the global plastic waste crisis and promote sustainable construction practices. The process involves collecting and sorting plastic waste, which can include various types of plastic packaging, bottles, and other discarded plastic materials. The collected plastic waste is then cleaned, shredded, and mixed with traditional brick-making materials such as clay, sand, and cement. The addition of plastic waste to the brick mixture offers several advantages. Firstly, it provides a viable solution for managing and recycling plastic waste that would otherwise end up in landfills or pollute the environment. By incorporating plastic waste into bricks, the volume of plastic waste is reduced, contributing to waste reduction goals. Additionally, this approach helps to conserve natural resources by reducing the demand for clay and sand, which are typically used in conventional brick production.

The inclusion of plastic waste also enhances the properties of the resulting bricks. Plastic materials act as binding agents, improving the cohesion and strength of the bricks. The resulting bricks exhibit increased durability, resistance to cracking, and improved thermal insulation properties. These characteristics make them suitable for a wide range of construction applications, from residential buildings to infrastructure projects. Furthermore, plastic waste bricks offer advantages, namely, reduction in cost and energy. The lightweight nature of plastic bricks reduces transportation costs and makes construction easier. The reduced weight also results in lower energy consumption during transportation and installation. Moreover, the enhanced thermal insulation properties of plastic bricks can contribute to energy-efficient buildings, reducing the need for heating and cooling and resulting in long-term energy savings.

However, challenges remain in the widespread adoption of plastic waste bricks. Proper sorting and cleaning of plastic waste are crucial to make sure that the quality and integrity of the finished product. Contamination from non-recyclable or hazardous plastic materials must be avoided. Standardized guidelines and regulations for manufacturing and quality control need to be established to ensure the safety and reliability of plastic bricks. Additionally, creating awareness among construction professionals and the general public about the benefits and potential of plastic waste bricks is essential for their acceptance and utilization on a larger scale.

Figure 1. Clay Bricks [7]

The scope of using plastic waste in manufacturing bricks presents an innovative and environmentally friendly solution to the growing problem of plastic waste. By incorporating the said waste into the making of bricks, we can address both the environmental impact of plastic waste and the resource-intensive nature of traditional brick manufacturing. Plastic waste, such as bottles and packaging materials, is shredded and mixed with clay, sand, and cement to create a new composite material for brick production. This approach not only reduces plastic waste in landfills but also conserves natural resources by decreasing the reliance on clay and sand. The resulting plastic bricks exhibit improved properties, including enhanced durability, thermal insulation, and reduced weight, making them suitable for construction applications. However, challenges such as proper waste sorting and quality control need to be addressed, along with the need for standardized guidelines and regulations, to ensure the widespread adoption and success of utilizing plastic waste in brick manufacturing.

The significance of Plastic clay Bricks

Plastic sand bricks, which are also referred to as plastic composite bricks, have emerged as a significant development in the construction industry because they provide numerous advantages over conventional bricks. Sand and waste plastic are used in the manufacturing process to make these bricks. Due to its advantages in terms of technology, economy, and the environment, this one-of-a-kind combination of materials has attracted attention. The positive impact they have on the environment is one of the primary benefits of plastic sand bricks. These bricks help reduce waste and encourage a circular economy by making use of plastic waste that would otherwise end up in landfills or pollute ecosystems. By introducing the use of plastic waste into the construction industry aids in minimizing the depletion of natural resources like clay and sand while simultaneously reducing the carbon footprint of traditional brick production methods. Plastic sand bricks offer numerous cost savings in terms of economic benefits. First, using plastic waste as a raw material cuts production costs overall. Furthermore, the lightweight idea of these blocks makes transportation and taking care of more proficient, bringing about decreased operations costs. Additionally, the improved thermal insulation properties of plastic sand bricks have the potential to reduce heating and cooling costs for end users and save energy in buildings..

From a technical standpoint, plastic sand bricks possess favorable characteristics. The inclusion of plastic waste enhances the durability and strength of the bricks, making them resilient to cracking and weathering. The composition of plastic and sand also improves the thermal insulation properties of the bricks, providing better energy efficiency in buildings. These bricks can be utilized in various construction applications, including residential, commercial, and infrastructure projects, demonstrating their versatility.

It is a vital to address some challenges associated with plastic sand bricks. Ensuring the proper segregation and cleaning of plastic waste is essential to maintain the quality and structural integrity of the bricks. Standardized guidelines and quality control measures are necessary to ensure the reliability and safety of these construction materials. Additionally, raising awareness among construction professionals, policymakers, and the general public about the benefits and potential of plastic sand bricks is crucial for their widespread adoption and acceptance.

1. Waste Management Solution: Plastic sand bricks provide a sustainable solution to the mounting problem of plastic waste. By diverting plastic waste from landfills or oceans and utilizing it in construction, these bricks contribute to waste reduction, helping to mitigate environmental pollution and promoting a circular economy.

2. Resource Conservation: : Plastic sand bricks provide a sustainable solution to the mounting problem of plastic waste. By diverting plastic waste from landfills or oceans and utilizing it in construction, these bricks contribute to waste reduction, helping to mitigate environmental pollution and promoting a circular economy.

3. Energy Efficiency: Plastic sand bricks have better properties for insulating heat, making buildings use less energy. These blocks give better protection against heat move, lessening the requirement for exorbitant warming or cooling. As a result, energy use and emissions of greenhouse gases are reduced, resulting in long-term energy savings and positive effects on the environment.

4. Enhanced Durability: The bricks' strength and durability are enhanced when plastic waste is used in the manufacturing process. Plastic materials go about as restricting specialists, working on the attachment and protection from breaking. Because of this increased durability, structures will last longer, necessitating fewer frequent replacements or repairs and saving money on maintenance.

5. Versatile Applications: Plastic sand bricks can be used for a wide variety of construction projects, including infrastructure, commercial, and residential ones. Their adaptability makes them reasonable for different structure types and development methods, growing their true capacity for broad reception and execution.

6. Economic Benefits: The economic benefits of plastic sand bricks include reduced production and transportation costs.

production costs, while their lightweight nature reduces transportation expenses. These economic benefits make plastic sand bricks an attractive option for builders and construction companies.

Applications of Plastic Clay Bricks

Sand clay bricks find diverse applications across the construction industry. In residential construction, they are used for load-bearing walls, partition walls, and exterior facades, providing durability, structural stability, and thermal insulation. Commercial buildings also benefit from sand clay bricks, as they are suitable for constructing office buildings, shopping malls, hotels, and educational institutions. The industrial sector utilizes these bricks in the construction of warehouses, factories, and storage facilities, thanks to their ability to withstand heavy loads and provide a secure environment. Sand clay bricks are also employed in infrastructure projects such as bridges, tunnels, and retaining walls due to their strength and resistance to environmental factors. Additionally, they find applications in landscaping, paving, and garden projects, including pathways, driveways, and raised beds. The versatility, strength, and aesthetic appeal of sand clay bricks make them an essential component in a wide range of construction applications.

Sand clay bricks find extensive applications in the construction industry due to their favorable properties and versatility. Some of the key applications of sand clay bricks are as follows:

1. Residential Construction: Sand clay bricks are widely used in the construction of residential buildings. They are commonly used for load-bearing walls, partition walls, and external facades. Their durability, strength, and thermal insulation properties make them suitable for creating structurally sound and energy-efficient homes.

2. Commercial Buildings: Sand clay bricks are utilized in the construction of various commercial structures, including office buildings, shopping malls, hotels, and educational institutions. Their fire resistance, acoustic insulation, and aesthetic appeal make them a preferred choice for these applications.

3. Industrial Construction: Sand clay bricks are well-suited for industrial construction projects. They are used to construct industrial warehouses, factories, storage facilities, and other industrial structures. The strength and durability of these bricks ensure that they can withstand heavy loads and provide a stable and secure environment for industrial operations.

4. Infrastructure Projects: Sand clay bricks are employed in the construction of infrastructure projects such as bridges, tunnels, and retaining walls. Their ability to withstand high compressive loads and resistance to environmental factors make them ideal for these applications.

5. Landscaping and Paving: Additionally, landscaping and paving projects utilize sand clay bricks. Pathways, driveways, patios, and other outdoor spaces can all be made with them. Sand clay bricks come in a wide range of colors, textures, and sizes, allowing for imaginative and pleasing designs.

6. Restoration and Conservation: Sand clay bricks are often utilized in restoration of historic buildings and heritage sites. Their compatibility with traditional construction methods and ability to replicate historical brickwork make them essential in preserving architectural heritage.

7. DIY and Garden Projects: Sand clay bricks can be utilized in various do-it-yourself (DIY) and garden projects. They can be used to build garden walls, raised beds, barbecues, and other outdoor structures, providing a versatile and customizable building material.

Figure 2. Sand Clay Brick

Advantages of Using Plastic Waste Bricks

Using plastic waste bricks has several advantages. First and foremost, it provides an effective solution for recycling and reusing plastic waste. Plastic waste, especially single-use plastics like bottles and bags, is a significant environmental problem. By incorporating plastic waste into bricks, it helps to divert this waste from landfills or from being dumped into oceans and rivers, reducing the amount of plastic pollution and its negative affect on the environment. Secondly, plastic waste bricks are lightweight in contrast to traditional clay or concrete bricks. This characteristic makes them easier to handle, transport, and install. It also reduces the structural load on buildings, making them suitable for constructing multi-story buildings. The lightweight nature of plastic waste bricks can help in reducing construction costs and improving the overall efficiency of the construction process. Another advantage of plastic waste bricks is their durability. Plastic bricks are highly resistant to weathering, pests, and moisture, which increases their lifespan compared to traditional bricks. This durability translates into long-term cost savings as there is less need for repair and maintenance.

Using plastic waste bricks offers numerous advantages, including:

1. Environmental sustainability: Plastic waste bricks provide a practical solution for managing and repurposing plastic waste. By incorporating plastic waste into bricks, it minimises the amount of plastic sent to landfills or ending up in natural ecosystems, thereby mitigating environmental pollution and its associated hazards.

2. Waste reduction and recycling: Plastic waste bricks promote the efficient recycling and reuse of plastic materials. Instead of adding to the growing plastic waste problem, these bricks allow for the repurposing of plastic waste into a valuable construction material, reducing the demand for virgin resources and lowering the overall waste generation.

3. Strength and durability: Plastic waste bricks possess impressive strength and durability properties. They can withstand heavy loads and exhibit resistance to weathering, moisture, and pests. As a result, structures built with plastic waste bricks can have a longer lifespan, reducing the need for frequent repairs or replacements.

4. Lightweight construction: Plastic waste bricks are typically lighter than traditional clay or concrete bricks. This characteristic makes them easier to handle, transport, and install, leading to faster and more efficient construction processes. Additionally, their lightweight nature can help reduce the overall weight on structures, making them suitable for various applications, including multi-story buildings.

5. Energy efficiency: Plastic waste bricks often have good insulation properties, which contribute to improved energy efficiency in buildings. The air pockets within the bricks create thermal barriers, reducing heat transfer and minimizing the need for excessive heating or cooling. This results in reduced energy consumption and lower carbon emissions, leading to cost savings and a smaller environmental footprint.

6. Cost-effective construction: Plastic waste bricks can offer cost savings in construction projects. The use of recycled plastic materials can be a more affordable alternative to traditional brick components. Additionally, their lightweight nature facilitates easier transportation and installation, reducing labor and logistics costs.

Scope of Using Plastic Waste in Bricks

The scope of using plastic waste in bricks is extensive and holds immense potential for addressing environmental, economic, and social challenges.

From an environmental perspective, the scope lies in tackling the plastic waste crisis. With plastic pollution reaching alarming levels, finding sustainable ways to manage and repurpose plastic waste is crucial. By incorporating plastic waste into bricks, a significant amount of plastic can be diverted from landfills, reducing the burden on waste management systems and preventing the pollution of ecosystems, including oceans and water bodies. This approach leads to a clean and healthy environment by minimizing the environmental impact of plastic waste. Economically, the scope of using plastic waste in bricks offers several opportunities. Firstly, it provides an avenue for creating a circular economy by transforming waste into a valuable resource. This can lead to the development of new industries and job opportunities focused on plastic waste collection, sorting, and processing. Additionally, using plastic waste in brick production can reduce the demand for traditional raw materials, such as clay or sand, thereby lowering production costs for brick manufacturers. Moreover, plastic waste bricks often have a longer lifespan and require less maintenance, resulting in cost savings over the life of a structure. In terms of social impact, using plastic waste in bricks can bring about positive change. It provides a scalable and practical solution that empowers local communities to actively participate in waste management and environmental initiatives. Plastic waste collection and processing can be organized at the community level, creating employment opportunities and promoting community engagement. Moreover, structures built with plastic waste bricks can provide improved living conditions, such as enhanced insulation properties that contribute to energy efficiency and comfort.

The scope extends beyond individual construction projects. It has the potential for large-scale adoption in the construction industry, including residential, commercial, and infrastructure development. Governments, organizations, and stakeholders can collaborate to develop standards, regulations, and incentives to promote the use of plastic waste bricks. Research and innovation can further enhance the quality, strength, and durability of these bricks, making them a viable and sustainable alternative to traditional construction materials.

CHAPTER 2
LITERATURE REVIEW

Plastic in Clay Bricks

Plastic-soil bricks, which have a binder (bitumen) content of 2% by weight of soil and a plastic content of 70% by weight of soil, yields a compressive strength of 8.16N/mm2, which is higher than that of late-rite stone (3.18N/mm2) and lower than that of literate stone (14.58%). Therefore, it may be an improved building material substitute [11].

Brick can make use of waste plastic, which can be found in every place. Plastic blocks can assist with diminishing the ecological contamination, in this way making the climate perfect and sound. Plastic sand bricks cut down on the use of clay in brick making. Plastic sand blocks give an elective choice of blocks to the clients on reasonable rates [2].

Water ingestion of plastic sand block is 0%. Compressive strength of plastic sand block is 5.6 N/mm2 at the compressive heap of 96KN. Contrasted with Fly Ash bricks and 3rd-class clay bricks, we come to the conclusion that plastic sand bricks provides more benefits to the construction industry [20]. A decent nature of paver block from modest unrefined substance can be accomplished. The most efficient approach to reducing waste will be one. Paver block is anticipated to be lighter than conventional paver block. Compositions made with aluminum foil will have a modestly higher compressive strength than traditional paver blocks. The unit weight of concrete is decreased when waste glass is used as fine aggregate. The percentage of water absorbed decreases as waste glass content rises [12]. The amount of glass in paving blocks decreases their cost. When compared to conventional paver blocks, the content of cement can be replaced by the use of melted plastic waste.

Additional benefits of plastic sand brick include cost effectiveness, resource efficiency, and a reduction in greenhouse gas emissions, among other things. Plastic sand block is otherwise called "Eco-Blocks" made of plastic waste which is generally destructive to all living organic entities can be utilized for development purposes. It has a higher compressive strength than fly ash bricks. The presence of alkalies' ability to absorb water was significantly reduced by using plastic sand bricks. Inferable from

Various advantages, future research would also improve quality and durability of plastic sand bricks[21].

Plastic is an imaginative material for involving it in development reason. A productive method for disposing of plastic waste is using plastic paver blocks. It exhibits superior outcomes, such as strength. The compressive strength is higher than that of standard paver blocks. When compared to concrete paver block, the utilization of plastic waste and copper slag lowers the price of paver block. This strategy is appropriate for the country which has challenging to arrange reused the plastic waste.vii) The consequences of compressive test shows that strength of paver block increments concerning the level of copper slag added by weight of fine total [14].

Expansion of copper slag expands the thickness and subsequently self weight and thus it is appropriate for bearing like Paver block. The addition of copper slag increased the material's workability. As copper slag is a high thickness materials it expands oneself load of paver block there by builds the strength and durability against the different sorts of burdens. This also suggests that the inclusion of copper slag in the paver block can improve its toughness and rigidity [26].

Bricks with varying mix proportions of plastic (PET, PP), laterite soil (passing 2.36mm IS Sieve), and bitumen content were tested for compressive strength and water absorption in this paper. According to the findings of this study, the strength of these bricks was influenced by the percentage of plastic used, and a trial-and-error method determined that plastic soil bricks needed at least 60% plastic by weight. In light of workability criteria, a dosage of 70% plastic by weight and an optimal binder content of 2% bitumen resulted in a compressive strength of 8.16N/mm2, which is higher than that of laterite stone (3.18N/mm2) and has less water absorption of 0.9536 percent than laterite stone. Thus, it tends to be a superior elective material and takes care of the issue of safe removal of plastics and viable usage of quarry squander is accomplished [5,6].

The purpose of this paper is to investigate the properties of bricks and paver blocks made from plastic waste, river sand, and colorants like red oxide [22]. Using a compressive testing machine and a water absorption test, various mixtures of river sand with plastic (1:2, 1:3, 1:4, 1:5, and 1:6) were checked for compressive strength. The study concluded that plastic soil bricks have more benefits like, reduced cost since, the natural resources used in the making of these bricks and paver blocks are significantly less when compared to traditional one. The manufacturing cost could further be reduced by replacing the river sand with fly ash/quarry dust or other waste products. Such bricks and paver blocks also ends the land requirement problem for dumping plastic wastes; also, the method is more suitable for countries which has difficult to dispose/ recycle the plastic wastes.

Plastic Disposal Sources

Plastic waste arises from various sources and poses a significant environmental challenge. The disposal of plastic waste is a complex issue that requires attention and effective waste management strategies.

One major source of plastic waste is packaging. The use of single-use plastics, such as plastic bags, bottles, and food containers, contributes to a substantial portion of plastic waste. These items are often used once and then discarded, leading to a rapid accumulation of plastic waste in landfills, water bodies, and natural environments [23]. Another significant source of plastic waste is the manufacturing sector. Plastic materials are widely used in industries for the production of consumer goods, electronics, automotive components, and construction materials. The manufacturing process generates plastic waste through production trimmings, rejected products, and packaging materials [24].

Plastic waste also originates from households and consumers. Everyday items like plastic cutlery, straws, and personal care product containers contribute to the growing plastic waste stream. Inadequate recycling infrastructure, lack of awareness, and improper disposal practices lead to a large portion of household plastic waste ending up in landfills or being improperly disposed of in the environment [33]. Furthermore, sectors such as agriculture and fishing contribute to plastic waste. Agricultural practices involve the use of plastic films, mulches, and irrigation systems, which can result in plastic waste at the end of their lifespan. Fishing activities generate plastic waste in the form of discarded fishing nets and gear, known as ghost gear, which poses a threat to marine life and ecosystems.

It is essential to address these diverse sources of plastic waste through comprehensive waste management approaches. This includes promoting recycling and circular economy initiatives, reducing single-use plastics, improving waste collection and segregation systems, and raising awareness among individuals, businesses, and industries about responsible plastic waste disposal. By tackling plastic waste at its source, we can mitigate its environmental impacts and work towards a more sustainable and plastic-conscious future.

Plastic Waste Characteristics in Clay Bricks

When incorporating plastic waste into clay bricks, it is important to consider the characteristics and properties of plastic waste and their impact on the final product. Here is a large paragraph discussing the plastic waste characteristics in clay bricks:

Plastic waste possesses unique characteristics that can influence the properties of clay bricks when incorporated into their manufacturing process. One crucial characteristic is the polymer type and composition of the plastic waste. Different types of plastics, such as polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyethylene terephthalate (PET), have varying chemical structures and physical properties. These variations can affect the overall strength, durability, and thermal properties of the resulting bricks. For instance, high-density polyethylene (HDPE) has a high melting point and good mechanical strength, making it a desirable plastic for improving the strength and durability of bricks. On the other hand, low-density polyethylene (LDPE) has a lower melting point and can contribute to the thermal insulation properties of the bricks. Understanding the specific polymer characteristics and compatibility with the clay matrix is crucial to achieving the desired performance of plastic waste bricks[31].

The size and form of the plastic waste particles also play a role in the properties of the bricks. The particle size distribution of plastic waste affects the workability of the brick mixture and the interlocking of particles within the matrix. Smaller plastic particles can enhance the homogeneity and interlocking of the brick materials, resulting in improved strength and durability. Conversely, larger plastic particles may lead to non-uniform distribution and reduced interlocking, potentially compromising the structural integrity of the bricks[28].

The proportion of plastic waste in the brick mixture is another critical factor. The optimal plastic waste content may vary depending on the specific application and desired properties of the bricks. Studies have shown that incorporating plastic waste in proportions ranging from 5% to 20% by weight can yield significant improvements in mechanical strength, water absorption, and thermal insulation properties of the bricks. However, exceeding certain plastic waste content thresholds may lead to undesirable effects, such as reduced compressive strength and increased brittleness. Therefore, it is important to find the right balance between plastic waste content and the desired properties of the bricks[36].

The processing conditions during brick manufacturing, such as mixing, molding, and firing, also influence the characteristics of plastic waste bricks. Adequate mixing and dispersion of plastic waste particles within the clay matrix are essential for achieving uniformity and optimal properties. Molding techniques, such as extrusion or compression molding, can affect the density, porosity, and surface finish of the bricks. Additionally, firing temperature and duration during the brick curing process can impact the mechanical strength, water absorption, and dimensional stability of the final product. Optimizing these processing parameters is crucial to ensuring the desired characteristics and performance of plastic waste bricks [9].

Chemical structure of a waste plastic

The monomer used in the making of Poly ethylene terephthalatelate (PET) is ethylene terephthalate. It is composed of the ethylene atom (- CH_2 – CH_2-), two ester particles (- COO-), and the terephthalate ring atom. The main nuclear species present in PET are accordingly hydrogen, oxygen, and carbon. Only water (H_2O) and carbon dioxide (CO_2) are produced when PET is burned. Therefore, even when PET is burned, there is no potential for the emission of harmful gases; however, the current work only required PET to be melted. The construction of the PET monomer is displayed underneath

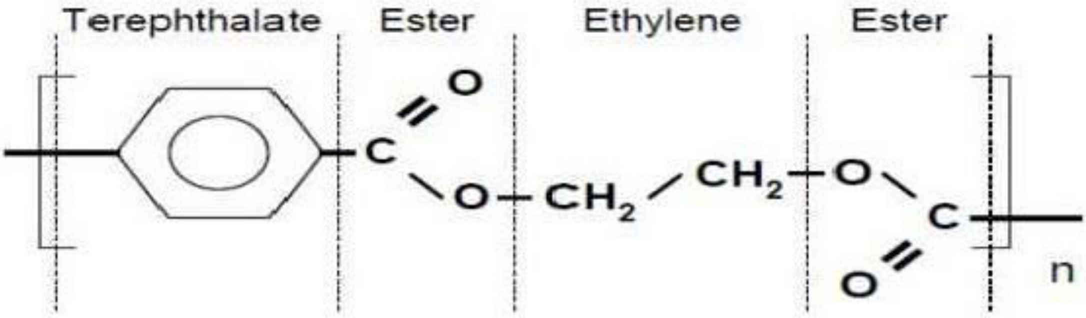

Figure 3. Chemical structure of the PET monomer

CHAPTER 3

MATERIAL AND METHODOLOGY

General

The utilization of plastic waste in the manufacturing of bricks is an innovative approach that addresses the growing concern of plastic pollution and the need for sustainable waste management solutions. This methodology involves several key steps to transform plastic waste into a valuable resource for brick production.

The first step is the collection and sorting of plastic waste. Various sources of plastic waste, such as single-use plastic bags, bottles, and packaging materials, are gathered and sorted based on their composition and quality. Sorting helps in separating different types of plastic and removing contaminants, which ensures a consistent quality of the final product.

Once the plastic waste is sorted, it undergoes a preprocessing stage. During this stage, the plastic waste is cleaned, shredded, and sometimes melted to obtain small plastic particles or fibers. The preprocessing step aims to enhance the plastic's workability and ensure its effective integration into the brick manufacturing process. The next step involves mixing the processed plastic waste with other materials commonly used in brick production. These materials often include clay, sand, cement, and water. The proportion of plastic waste in the mixture varies depending on the desired properties of the final bricks. The mixing process ensures a homogeneous distribution of plastic particles within the mixture, promoting their effective bonding with other materials.

After the mixing stage, the plastic waste-infused mixture is molded into brick shapes using traditional brick-making techniques or specialized machinery. The molding process can involve pressing the mixture into molds or extruding it through a machine to form continuous bricks. The bricks are then left to dry and undergo curing, allowing them to gain strength and stability.

The final step is the quality control and testing of the manufactured plastic bricks. These bricks are subjected to various tests to ensure their durability, strength, and other desired characteristics meet the required standards. Testing may include assessments of compression strength, water absorption, and resistance to environmental.

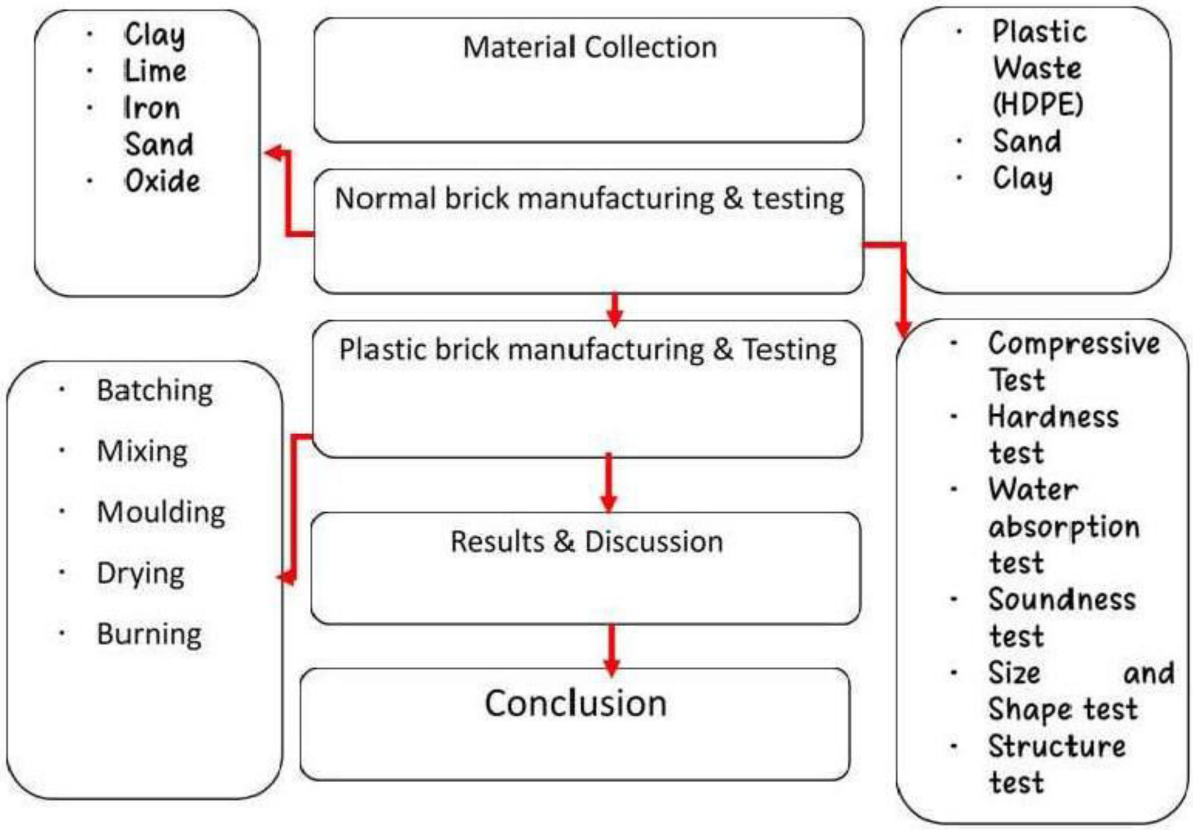

Figure 4. Methodology Chart

Plastic Waste

Plastic waste refers to any discarded or unwanted plastic material that has reached the end of its useful life and is no longer needed or desired. It encompasses various forms of plastic, including single-use items like bags, bottles, food packaging, straws, and disposable utensils, as well as larger plastic items such as electronic waste, broken toys, and packaging materials. Plastic waste is a significant environmental concern due to its non-biodegradable nature, meaning it does not break down easily in the environment. When improperly disposed of, plastic waste can persist for hundreds of years, polluting ecosystems, harming wildlife, and posing risks to human health.

The production and consumption of plastic have increased rapidly over the years, leading to a surge in plastic waste generation. The improper management of plastic waste, including inadequate recycling infrastructure and widespread littering, has resulted in significant environmental and social consequences.

Efforts to address plastic waste involve reducing its generation through measures like plastic bans and restrictions, promoting recycling and waste management systems, and exploring innovative solutions such as using plastic waste in manufacturing processes like brick production, as mentioned earlier. These initiatives aim to minimize the negative impacts of plastic waste and transition towards a more sustainable and circular economy.

TABLE 1. ORIGIN OF PLASTIC

Waste Plastic	Available as
Poly ethylene terephthalate (PET)	Drinking water bottles etc.
High Density Poly ethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Low Density Poly ethylene (LDPE)	Milk pouches, sacks, carry bags, bin linings, cosmetics and detergent bottles.
Poly propylene (PP)	Bottle caps and closures, wrappers of detergents, biscuit etc.
Urea formaldehyde	Electrical fittings ,handles and knobs
Polyester resin	Casting, bonding fibers (glass, Kevlar, carbon fiber)

Material Used

Clay:

Clay material are composed essentially of silica, alumina or magnesia or both and water.

Figure 5. Clay

Sand:

Based on the grain size of the particle, sand is classified as Fine Sand (0.075 to 0.425mm), Medium Sand(0.425 to 2mm), and Coarse Sand (2.0 mm to 4.75mm).

Figure 6. Sand

Plastic waste

Plastic, polymeric material that has the capability of being molded or shaped, usually by the application of heat and pressure.

Polythene HDPE

Plastic bottles (PET) Plastic wastes

Figure 7. Plastic Waste

Water:

Water is a very essential element in construction and is required in the preparation of mortar, bricks, mixing of cement concrete and for curing work etc. The quality of water used directly impacts the strength of the mortar and cement concrete in the construction work.

Brick Mould:

The brick mould was made of metal as well as wooden by man-made According to standard brick size, i.e. 190mm x 90mm x 90mm.

Figure 8. Mould

COAL

Coal is basics source that is utilized for burning of bricks.

Figure 9. Coal

ELECTRIC MOTOR

Figure 10. Electric motor

It is used to maintain the temperature in chimney. It operates when the bricks are getting burnt so that the smoke gets accumulated at one place and can easily find its way out of the chimney.

KILN/CHIMNEY

Bricks are typically manufactured in kilns using a process called firing. Here are the basic steps in the brick manufacturing process:

1. Preparation of raw materials: The raw materials for making bricks include clay, water, and other additives such as sand or sawdust. These materials are mixed together to form a clay body.

2. Molding: The clay body is then molded into the desired shape, either by hand or using a machine.

3. Drying: The molded bricks are then allowed to dry for several days until they are hard enough to be fired.

4. Firing: The dried bricks are placed in a kiln and fired at high temperatures, typically between 800 and 1200 degrees Celsius. The firing process can take several days to complete, depending on the size and thickness of the bricks

5. Cooling: After the firing process is complete, the kiln is allowed to cool and the bricks are removed.

6. Sorting and packaging: The bricks are then sorted based on their quality and packaged for distribution and sale.

Overall, the process of manufacturing bricks in a kiln involves a combination of preparation, molding, drying, firing, cooling, and sorting/packaging. The specific details of the process can vary depending on the type of kiln and the specific materials used.

Figure 11. Chimney/Klin

Test Methods:

Tests for clay

BALL TEST:

The is done to determine the ratio of clay to sand in soil. Take some dirt and add some water to it. Mix the dirt and water well with the palm and fingers. Try to shape a ball out of the soil once it has been evenly mixed. Look at how smooth the ball's surface is. Additionally, it will be challenging to create a ball with a spherical form on sandy soil.

WET BALL TEST:

After the ball is well formed, immediately drop the ball from a height of at least 1 m . The area must be level and spotless before the ball is dropped. Look at the ball on the ground. The soil is plastic clayey if the ball maintains its shape with just minor deformation at the bottom. On the other hand, if the ball flattens out when it hits the ground, indicated the soil to be sandy.

DRY BALL TEST:

In rehashing the test on the off chance that the ball breaks into numerous pieces after touching the floor, the dirt is sandy in nature. Be that as it may, on the off chance that the ball distortes into a few pieces, the indication is that the dirt have a clayey and plastic nature.

TESTS FOR BRICKS

COMPRESSIVE STRENGTH:

Four examples of blocks were taken to lab for testing and tried individually. A brick specimen is crushed by applying pressure until it breaks in this test. The final crushing pressure of the brick is taken into account.

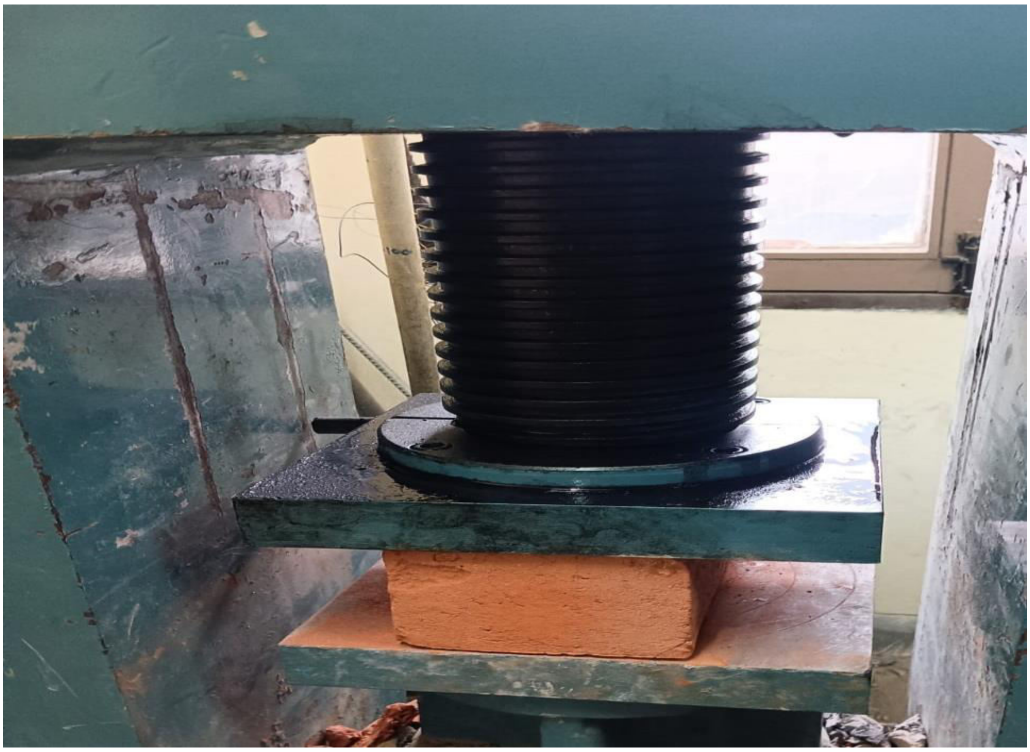

Figure 12. Compressive Test

WATER ABSORPTION TEST:

To test the water absorption capacity, bricks are firstly to be weighed in dry condition and then immersed in fresh water for 24 hours. After 24 hours, the bricks are to be taken out from water and wiped with cloth. Then, brick is weighed in wet condition. The difference between weights will give the water absorbed by brick. The percentage of water absorption then can be calculated. Less water absorbed by brick indicates better quality. Good quality brick doesn't absorb more than

20% water of its own weight.

Figure 13. Water Absorption Test

SHAPE AND SIZE TEST:

The best bricks for construction should be rectangular in shape and have a length of 19 centimeters, a width of 9 centimeters, and a height of 9 centimeters. Stack around twenty bricks along its length, height, and width for a straight forward test..

Figure 14. Shape and Size Test

CLASSIFICATION OF BRICKS

ON FIELD PRACTICE.

On the bases of their physical and mechanical properties, clay bricks fall into four classes: first, second, third, and fourth..

First Class Bricks

1. These are cherry, copper, or deep red in color and have been completely burned.
2. Smoothness and a rectangular shape are required, as are sharp, parallel, straight edges and square corners.
3. These ought to be liberated from blemishes, breaks and stones.
4. The texture should be uniform.
5. When a finger nail scratches the brick, it shouldn't leave any marks.
6. When two bricks collide, there should be a metallic or ringing sound.
7. When immersed in cold water for 24 hours, water absorption should be between 12 and 15 percent of its dry weight. The brick should have a crushing strength of at least 10 N/mm2. The limit can vary across the nations and various government agencies.

Uses: For pointing, flooring, exposed face work in masonry structures, and reinforced brick work, first-class bricks are recommended.

The requirements for second-class bricks are supposed to be the same as for first-class bricks, with the exception of

1. Allowable are the smallest distortions and cracks.
2. It is permitted to absorb slightly more water—roughly 16 to 20 percent of its dry weight
3. The crushing strength ought not be under 7.0 N/mm2.

Uses: Inferior blocks are suggested for immensely significant or irrelevant secret workmanship works and focusing of supported block and built up concrete cement (RCC) structures.

Second rate Class Blocks are under scorched. When struck against one another, they have a light color and are soft, which results in a muffled sound. Water assimilation is around 25% of dry weight.

Uses : It is used to construct temporary buildings..

IV class bricks are generally over-burned, have significant distortion in size and shape, and brittle in nature. Uses: The kind of bricks are used as ballast for the floors and foundations of lime concrete and road metal.

ON THE BASIS OF USE

The general work that can be used for many things and is made cheaply without paying special attention to appearance is common bricks. They can be used for various purposes like filling, backing, and in walls where appearance is not important. Their strength and durability can vary greatly.

Facing bricks are mostly made to look good, either in terms of color, texture, or both. These are used in front of building walls where a pleasing appearance is desired and are durable under severe exposure.

Engineering bricks conform to specified absorption and strength limits and are strong, impermeable, smooth, and table-molded. These are utilized for all heap bearing designs.

ON THE BASIS OF FINISH

The inner surfaces of the mold were sprinkled with sand to create the textured surface of the Sand-faced Brick. Rustic Brick has mechanically textured finish which varies in pattern.

ON THE BASIS OF MANUFACTURE

Hand-made: The bricks which are molded by hand.

Machine-made: Contingent on mechanical plan, blocks are known as wire-cut blocks cut from dirt expelled in a segment and cut to be divided into block sizes by wires; pressed bricks are made by pressing bricks into molds made of semi dry clay or stiff plastic; formed blocks when blocks are shaped by machines emulating hand blending.

ON THE BASIS OF BURNING

The bricks that come from the kiln's exterior are called Pale Bricks which are also unburnt. The central portion of the kiln is occupied by Body Bricks, which are well-burnt bricks.
Curve Blocks are over singed otherwise called clinker blocks got from internal piece of the furnace.

ON THE BASIS OF TYPES

Solid: Little openings not surpassing twenty five percent of the volume of the block are allowed; alternatively, frogs are permitted to make up no more than 20% of the total volume.

Perforated: Small holes can exceed by 25 % of the total volume of the brick.

Hollow: It is possible for the entirety of the holes, which need not be very small, to exceed 25% of the brick's volume. Cellular: Over 20% of the volume is contained within closed holes at one end. Note: The cross section of a small hole is less than 500 mm2 or less than 20 mm.

CHAPTER 4

RESULT AND DISCUSSION

WATER ABSORPTION TEST

TABLE 2: Water Absorption

Plastic content(%)	Dry weight W1 (KG)	Weight of Specimen after immersion in water W2 (kg)	% of water absorption
0%	2.510	2.950	17.52%
5%	2.930	3.370	15.01%
10%	2.880	3.350	23.26%
15%	2.850	3.350	24.56%

Water absorption test= $\frac{W1-W2}{W1}$ **X 100%**

Where

W1=Dry weight of brick.

W2=Weight of brick after immersion in water.

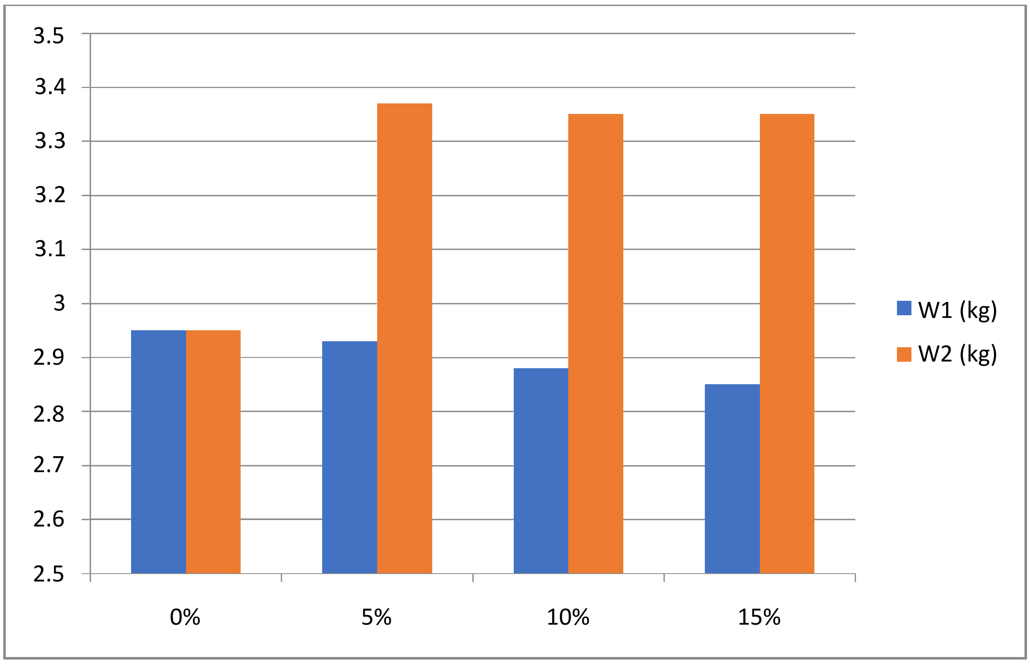

Figure 15. Graph of comparison between W1 & W2

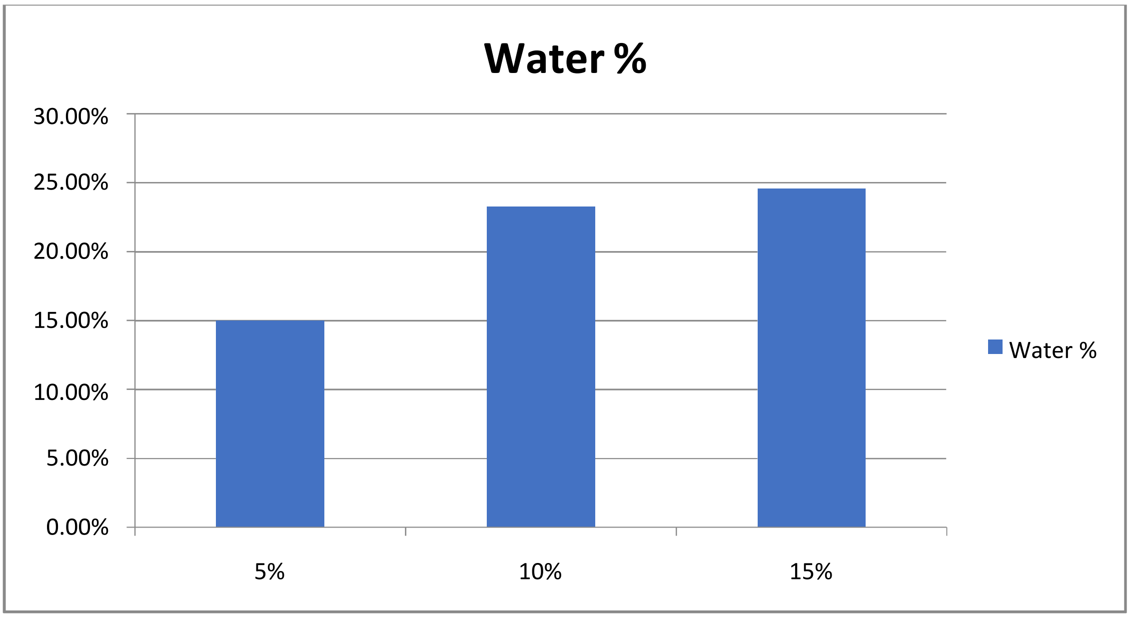

Figure 16. Graph of Water absorption

We have performed the water adsorption tests for all kind of bricks that we have made and it is concluded that among all the bricks, all of them are having less than 25 % water absorption values which means that all the bricks are first classs bricks. First class bricks are those bricks having less than 25 % water absorption.

COMPRESSIVE STRENGTH TEST

TABLE 3: Compressive Strength

	Load(Kn)	Area (mm^2)	Compressive strength
0%	60	2000	30
5%	110	2000	55
10%	115	2000	57.5
15%	90	2000	45

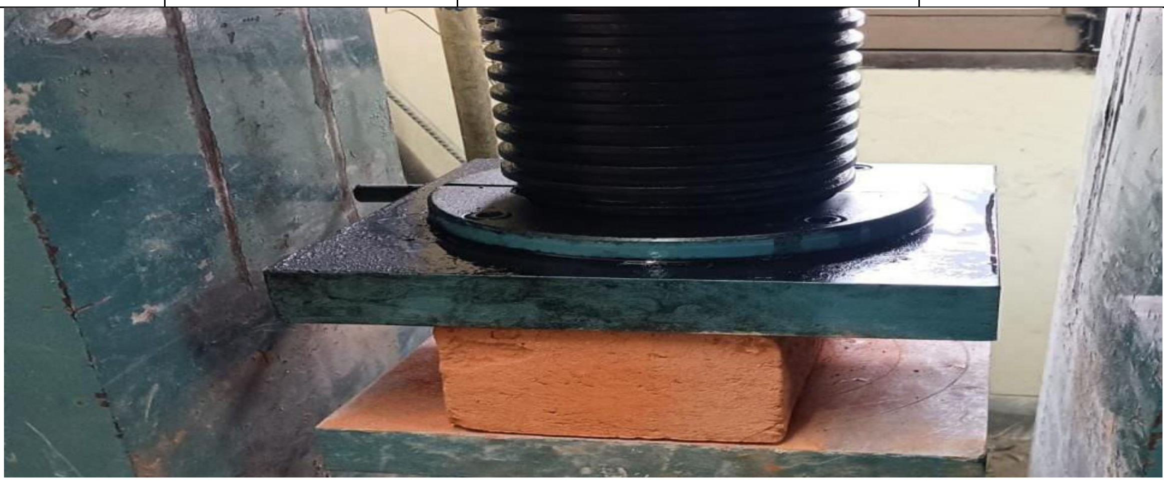

Figure 16. Compression Test

Figure 17. Plastic Brick after compaction

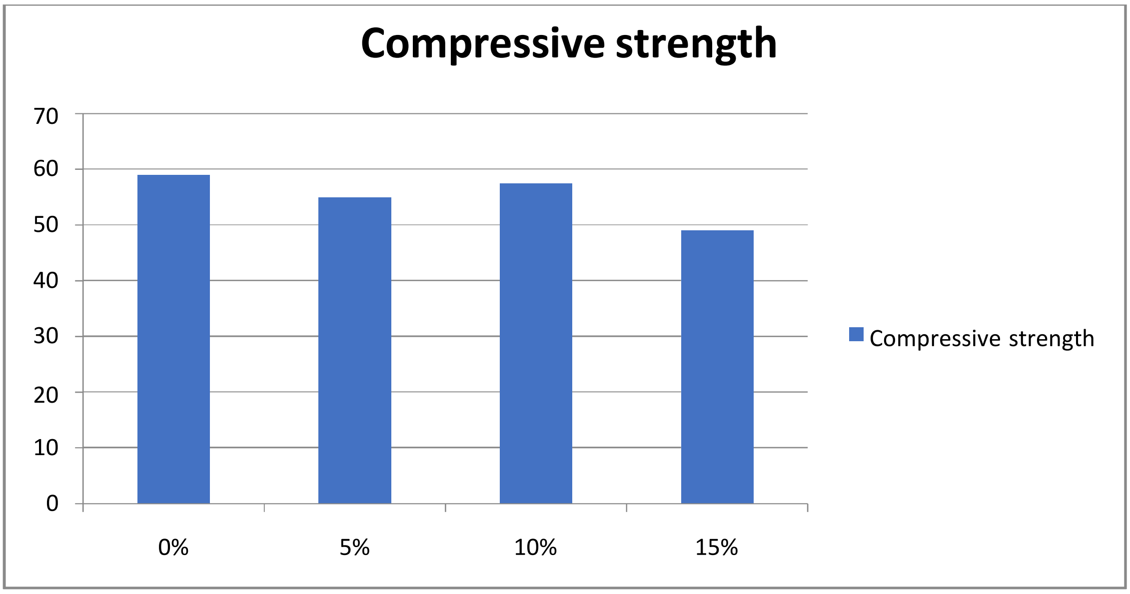

Figure 18. Compressive Strength Values

The compressive strength values of the bricks that we have made of plastic is coming out to be maximum when the plastic waste content is 10 % and it is coming out to be lowest when the content of plastic waste is 15 %. At 5% value of the content of plastic waste, the compressive strength value is coming out to be around 55 and in case of 0 % content of plastic waste content, the compressive strength is coming out to be around 58.

SHAPE AND SIZE TEST

Figure 19. Comparing plastic brick with standard size brick

We have compared the shape and size of both the bricks, i.e. the standard bricks as well as the bricks made of plastic waste. The conclusion that came out is that the shape and the size of the plastic bricks as well as the shape and size of standard bricks is same and coming in the order 20cm *10 cm * 10 cm.

SOUNDNESS TEST

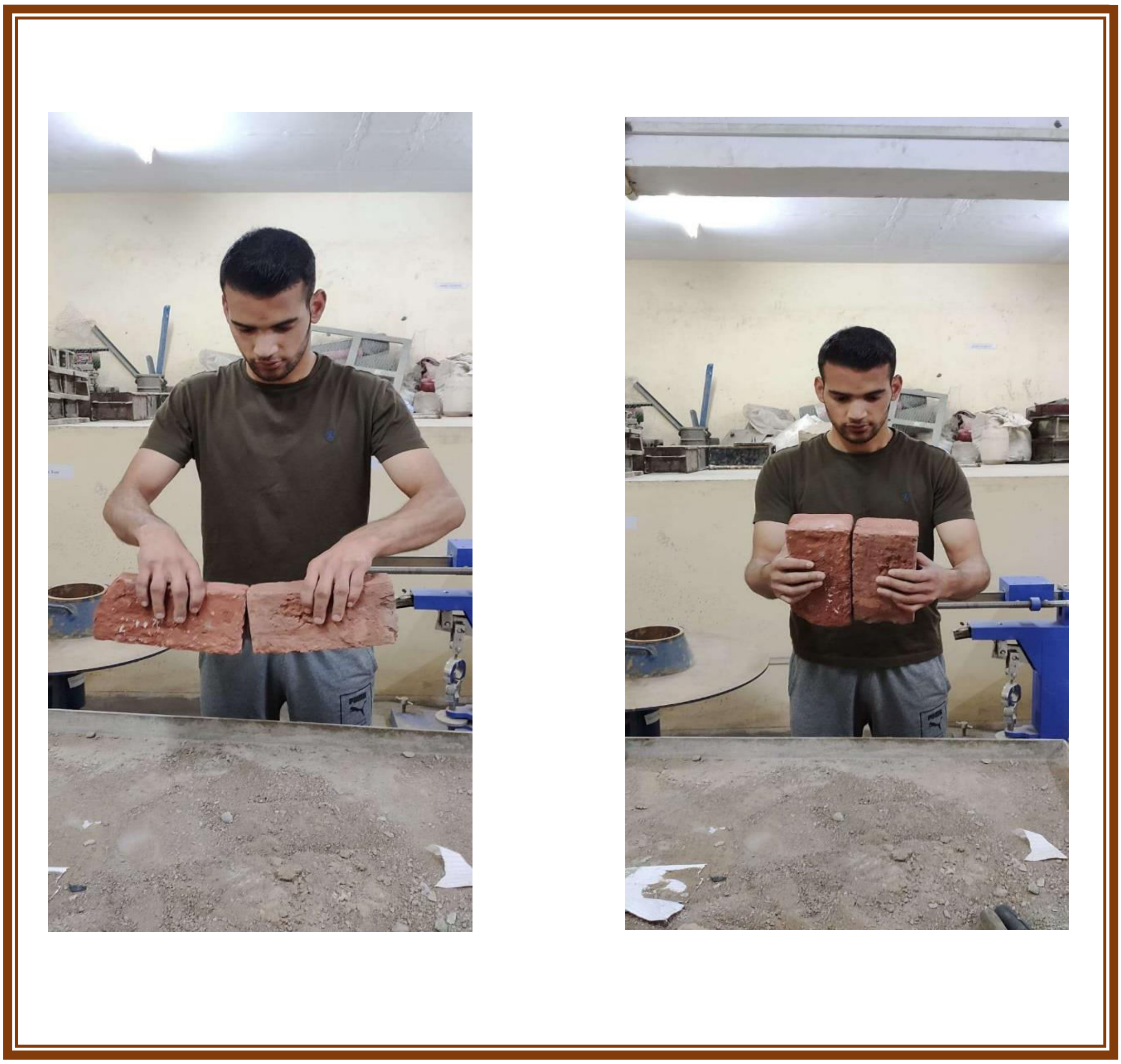

Figure 20. Soundness Test

Soundness test is done on bricks in which the metallic sound is produced. The soundness test is being done for both the kind of brics i.e. the standard bricks as well as the bricks that contain the plastic waste content

CHAPTER 5
CONCLUSION AND FUTURE SCOPE

Conclusion

1. The use of plastic waste in brick production can address the challenges of plastic waste management and sustainable construction practices.
2. Consolidating plastic waste in block creation can work on the properties of the blocks and decrease the natural effect of waste plastics.
3. The quality and consistency of the plastic waste must be ensured, and the cost-effectiveness of using plastic waste in brick production needs to be evaluated.
4. Further research and development are needed to optimize the use of plastic waste in brick production and promote its wider adoption in the construction industry.
5. Collaboration between governments, industries, and communities is necessary to develop policies and initiatives that support the circular economy and sustainable development goals.
6. Using 10% plastic waste content in brick production shows good compressive strength and soundness tests compared to other percentages of plastic waste content.
7. Utilizing plastic waste in the manufacturing of bricks offers a promising solution to address the environmental and economic challenges associated with plastic waste management and sustainable construction practices.

Future Scope

1. The study can be preceded further with the use of use of Autoclaved cement concrete brick inclusive with shredded plastic.

2. .The effect of plastic on the microstructure of the clay-plastic bricks can be studied to analyze the behavior of plastic.

REFERENCES

1. Singh, N., et al. "Properties of plastic bricks containing up to 10% waste plastic." Waste Management & Research 28.8 (2010): 783-790.

2. Rana, Anshul, and S. Suresh Kumar. "Utilization of waste plastic in manufacturing of plastic–sand bricks." International Journal of Earth Sciences and Engineering 4.4 (2011): 657-662.

3. Sridhar, R., et al. "Studies on the thermal and mechanical properties of plastic waste–sand bricks." Materials Today: Proceedings 5.11 (2018): 22016-22024.

4. Singh, B. "Use of waste plastic in construction of bituminous road." International Journal of Engineering Research & Technology 3.3 (2014): 1895-1900.

5. Khan, M., et al. "Utilization of waste plastic in bituminous mixes for road construction." Journal of Materials in Civil Engineering 24.7 (2012): 802-809.

6. Chandra, S., and S. Chandra. "Waste plastic as a stabilizing additive in stone matrix asphalt." Construction and Building Materials 22.4 (2008): 712-717.

7. Das, S., and S. Chandra. "Influence of waste plastic as bitumen modifier on hot mix asphalt." Journal of Materials in Civil Engineering 23.1 (2011): 73-79.

8. Siddique, R., and K. Khatib. "Use of waste plastic in concrete mixture as aggregate replacement." Waste Management 28.11 (2008): 2041-2047.

9. Siddique, R., et al. "Properties of concrete containing scrap-tire rubber—an overview." Construction and Building Materials 24.3 (2010): 886-895.

10. Mageswari, D., et al. "Performance of concrete with plastic waste as a partial replacement for sand." Waste Management 28.11 (2008): 2048-2054.

11. Siddique, R., and M. N. Islam. "Properties of concrete containing shredded carpet waste as a replacement for fine aggregate." Construction and Building Materials 25.2 (2011): 1040-1045.

12. Khedkar, M., and S. Kadam. "Use of waste plastic in concrete mixture as aggregate replacement." International Journal of Engineering Science and Technology 2.8 (2010): 3717-3724.

13. Korhonen, C. J., et al. "Recycling plastics as aggregate in concrete." Waste Management 21.7 (2001): 747-758.

14. Zhang, S. H., et al. "Effect of waste PET bottles aggregate on the mechanical properties of concrete." Materials and Design 37 (2012): 802-809.

15. Kumar, D., et al. "Experimental study on utilization of plastic waste as fine aggregate in concrete." Journal of Cleaner Production 112 (2016): 625-638.

16. Wagh, Ashwini S., and Subhash N. Kulkarni. "Experimental investigation of waste plastic bottle chips as partial replacement of coarse aggregate in concrete mix." International Journal of Scientific and Research Publications 6.1 (2016): 179-185.

17. Gupta, M., et al. "Waste plastic as a partial replacement of coarse aggregate." International Journal of Innovative Research in Science, Engineering and Technology 2.2 (2013): 336-340.

18. Narayanan, Neithalath, et al. "Utilization of post-consumer plastic waste in the manufacture of lightweight aggregates." Journal of Cleaner Production 53 (2013): 297-304.

19. Raut, S. P., and V. V. Ralegaonkar. "Development of sustainable construction material using industrial and agricultural solid waste: A review of waste-create bricks." Construction and Building Materials 25.10 (2011): 4037-4042.

20. Agopyan, V., et al. "Recycling of waste plastic into lightweight aggregate." ACI Materials Journal 91.6 (1994): 567-573.

21. Ehrampoush, Mohammad Hassan, et al. "The utilization of plastic waste as a secondary fuel in cement production." Journal of Cleaner Production 20.1 (2012): 212-219.

22. Saffari, H., et al. "Utilization of waste plastics as a co-fuel in cement kilns." Journal of Environmental Management 123 (2013): 75-81.

23. Gómez-Soberón, José Manuel, et al. "Waste plastics as alternative fuel for cement kilns." Waste Management 27.2 (2007): 187-194.

24. Jones, M. R., and L. W. Shannon. "Properties of clay bricks containing municipal solid waste incinerator ash and scrap tire rubber." Waste Management & Research 22.5 (2004): 341-348.

25. Agrawal, R. K., et al. "Studies on properties of clay bricks blended with fly ash and sewage sludge." Construction and Building Materials 20.8 (2006): 532-537.

26. Singh, A., and S. Shukla. "Assessment of performance of clay bricks containing waste glass." Waste Management & Research 25.3 (2007): 246-252.

27. Khan, M. I., et al. "Utilization of marble and granite waste in concrete bricks." International Journal of Physical Sciences 5.9 (2010): 1372-1380.

28. Singh, N. B., et al. "Compressive strength of plastic bricks containing fly ash." Journal of Materials in Civil Engineering 20.7 (2008): 465-469.

29. Ali, A., et al. "Properties of bricks made using fly ash, quarry dust and billet scale." Construction and Building Materials 66 (2014): 583-590.

30. Taha, B., et al. "Recycling waste plastics in construction materials: Recent developments." Waste Management 34.12 (2014): 2201-2217.

31. Das, S., et al. "Influence of waste plastic as partial replacement of fine aggregate on concrete properties." Journal of Cleaner Production 135 (2016): 103-114.

32. Tepordei, V., and E. Ionascu. "Recycling of plastics in prefabricated construction elements." Construction and Building Materials 25.4 (2011): 1581-1586.

33. Wastiels, J., et al. "Study of waste plastic mixtures as a new material for construction applications." Waste Management 31.6 (2011): 1223-1231.

34. Akbari, H., et al. "Feasibility of using post-consumer waste plastics as raw material in concrete blocks." Construction and Building Materials 47 (2013): 1216-1220.

35. Ramesh, M., et al. "Utilization of waste plastic bottles in asphalt mixture." Journal of Materials in Civil Engineering 20.9 (2008): 623-628.

36. Siddique, R., and I. Ahmad. "Use of plastic waste as aggregate in cement mortar and concrete preparation: A review." Construction and Building Materials 34 (2012): 385-401.

37. Khan, N. A., et al. "Feasibility of using waste glass in the production of cement and concrete." Construction and Building Materials 37 (2012): 709-715.

38. Kotrayya, G., and S. B. Kulkarni. "A review on the use of plastic waste in bricks." International Journal of Emerging Technology and Advanced Engineering 3.10 (2013): 15-18.

39. Pacheco-Torgal, F., et al. "Ceramic products with improved mechanical properties, moisture durability and reduced environmental impact produced with addition of waste." Journal of Cleaner Production 20.1 (2012): 71-78.

40. Chandra, S., et al. "Evaluation of bricks containing recycled plastic waste." Waste Management & Research 26.5 (2008): 480-486.

41. Kshirsagar, V. P., and M. A. Ayub. "Study on bricks made from waste mud." Journal of Materials in Civil Engineering 20.7 (2008): 461-464.

42. Akinyemi, O. D., et al. "Utilization of waste plastic bottles as fine aggregate in concrete." Journal of Materials in Civil Engineering 28.2 (2016): 04015121.

43. Yıldız, A., and M. S. Aras. "Production of bricks from waste materials–a review." Journal of Cleaner Production 236 (2019): 117636.

44. Sabur, M. A., et al. "Utilization of plastic waste in manufacturing of lightweight concrete." IOP Conference Series: Materials Science and Engineering. Vol. 160. No. 1. IOP Publishing, 2016.

45. Janarthanan, K., et al. "Investigation on the use of recycled PET bottles as concrete material." Journal of Cleaner Production 248 (2020): 119261.

46. Taghizadeh, S., et al. "Experimental investigation of using recycled waste plastic in concrete." Journal of Building Engineering 29 (2020): 101173.

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: ……………………………

Type of Document (Tick): PhD Thesis | M.Tech Dissertation/ Report | B.Tech Project Report | Paper

Name: ___________________________ __**Department:** _________________ **Enrolment No** _________

Contact No. ______________________________**E-mail.** ______________________________________

Name of the Supervisor: ____

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): ________________________

____

____

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages =
- Total No. of Preliminary pages =
- Total No. of pages accommodate bibliography/references =

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at ………………..(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

(Signature of Guide/Supervisor) **Signature of HOD**

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Generated Plagiarism Report Details (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature **Librarian**

……

Please send your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through the supervisor at plagcheck.juit@gmail.com