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ORIGINAL CONTRIBUTION

# Development and Assessment of the Mechanical Properties of the Lightweight Brick Masonry Unit Utilizing Expanded Polystyrene Beads (EPB)

Muhammad Umair [1*], Kazim Ali [2], Salman Khan[3], Muhammad Farhan Aslam [4]
Huma Rahman [5], Sami Ullah [6]

[1] Superior University, Lahore, Pakistan

[2] Technical Research Center of Shenzhen University, Shenzhen, China

[3, 4] Quaid-e-Azam College of Engineering and Technology, Sahiwal, Pakistan

[5] National Institute of Urban Infrastructure Planning, University of Engineering and Technology, Peshawar, Pakistan

[6] Mirpur University of Science and Technology, Mirpur, Pakistan

***Abstract*— The application of polystyrene beads as a sustainable substitute in the production of soil-based bricks is investigated in this study. The objective of the research is to evaluate the mechanical and thermal characteristics of soil-brick composites at ratios of 4%, 8%, and 12% that contain different amounts of polystyrene beads. The purpose of the study is to determine how the inclusion of polystyrene beads affects the final composite bricks' insulating properties and structural integrity. Initial results indicate that the addition of polystyrene beads noticeably affects the mechanical and thermal properties of the composite bricks. According to preliminary findings, insulating qualities may get better as polystyrene ratios rise, but maintaining structural integrity requires striking a compromise. The results of this study provide important new information on the feasibility of using earth bricks augmented with polystyrene as an energy- and environmentally-friendly building material. More research and optimization efforts are advised to improve the composition and overall performance of these composite bricks for use in sustainable buildings..**

***Index Terms*— Bricks, Polystyrene, Strength, Thermal insulation, XRD, SEM**

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## I. INTRODUCTION

The global construction industry faces a critical juncture in the 21st century, grappling with the urgent need for sustainable practices to counteract the environmental toll associated with traditional building materials [1]. Among these materials, conventional bricks, a cornerstone of construction for centuries, are emblematic of both the durability and environmental challenges inherent in the industry [2]. In response to this, contemporary research is steering towards innovative approaches to revolutionize brick manufacturing, with an emphasis on sustainability. Polystyrene, a widely used plastic material, possesses unique properties that make it a compelling candidate for integration into construction materials. Its lightweight nature, low thermal conductivity, and excellent insulation properties have led to its use in various applications [3]. The utilization of polystyrene not only provides a means to recycle this commonly discarded material but also has the potential to address the issues of weight and insulation in conventional bricks [4]. In recent years, the global construction industry has been grappling with the pressing need for sustainable practices to mitigate the environmental impact of urban development. As societies evolve, so does the demand for construction materials that not only meet structural requirements but also align with ecological principles [5]. One such material that has garnered attention for its potential to transform the construction landscape is polystyrene. Traditionally known for its use in packaging and insulation, polystyrene is now emerging as a promising candidate in the production of eco-friendly bricks, presenting a paradigm shift in sustainable construction. The conventional construction industry has long been associated with resource-intensive practices and the generation of vast amounts of non-biodegradable waste [6]. The pressing challenges of climate change and resource depletion have prompted researchers and industry professionals to seek alternative materials that minimize environmental impact without compromising structural integrity. The utilization of polystyrene in construction marks a departure from traditional brick manufacturing processes, which often involve the extraction of clay, a resource-intensive activity contributing to soil degradation. Additionally, the firing of clay bricks in kilns is a significant source of greenhouse gas emissions.

Polystyrene-based bricks present a compelling case for sustainability due to their reduced environmental footprint [7]. The incorporation of

*Corresponding author: Muhammad Umair
†Email: umairbaloch14@gmail.com

polystyrene in brick production not only diverts this material from landfills but also reduces the demand for traditional raw materials, thereby conserving natural resources. Furthermore, the manufacturing process of polystyrene bricks involves lower energy consumption compared to conventional brick production methods, offering a significant reduction in carbon emissions. Critics may raise concerns about the structural integrity and durability of polystyrene-based bricks [8]. Studies have suggested that polystyrene bricks exhibit favorable insulation properties, contributing to energy efficiency in buildings. Moreover, their lightweight nature may offer advantages in construction speed and ease of handling [9, 10]. As the construction industry seeks sustainable alternatives, various researchers and industry players have explored the incorporation of polystyrene in brick production. The construction industry is a significant contributor to environmental degradation, with the production of traditional building materials often associated with high energy consumption and greenhouse gas emissions. In recent years, there has been a growing emphasis on sustainable and eco-friendly construction practices to mitigate these environmental impacts [11]. One promising avenue is the exploration of alternative materials and innovative manufacturing processes for traditional construction materials such as bricks. Traditional brick manufacturing relies heavily on clayey soil, a finite resource with considerable environmental consequences associated with extraction. Moreover, the firing process in brick production releases significant amounts of carbon dioxide, contributing to greenhouse gas emissions. In an era dominated by ecological consciousness, the imperative to reimagine construction materials and processes is paramount [12, 13].

A brick may be made from clay–bearing soil, sand, lime, or stable substances. Bricks are mass-produced in various classes, kinds, substances, and sizes, which differ with vicinity and time-body, and are produced in mass amounts. Fundamental instructions for bricks are fired and non-fired bricks [14]. Bricks are an essential material of construction needed in all kinds of constructional sports and include approximately 13 % of the whole rate of constructing substances wished for creation. It's been set up that the usage of clay bricks delivers superior and comfy physical dwelling situations compared to the usage of various materials as far as residential construction is concerned [15, 16]. Despite all projects to present alternative walling materials like compacted earth block, stable/stone Crete block, and fly ash brick, it is visualized that burnt clay brick could still occupy the dominant function. In any other case, earth buildings and unfired clay brickworks are evolved using earth materials (possibly with sure added substances). Earth building isn't always "fired" like regular bricks, yet the shape devices are air-dried after manufacturing to lessen shrinkage and improve strength. In some traditional varieties of earth creation (e.g., Cob or rammed earth), stable (strong) partitions are evolved, yet unfired clay bricks are the same as other structure frameworks in which there the units (bricks) are bolstered together with mortar and probably blanketed with a finishing framework (paint or render). General types of unfired clay bricks (cob blocks, adobe, and dirt bricks) are usually made by hand and, therefore, have specific measurements and unique properties. Conventional earth buildings have thicker walls (often greater than three hundred mm thick) because the mortar offers low-bond electricity, and the thicker partitions have adequate mass to maintain them strong against lateral loads in dwellings. The global construction industry's impact on the environment has spurred research into sustainable construction materials. Alternative materials, such as recycled plastics, have gained attention for their potential to reduce the environmental footprint of traditional construction processes [17]. Polystyrene has been explored in various construction applications, including lightweight concrete and insulation boards. The material's unique combination of low density and high strength makes it an attractive option for enhancing the properties of traditional construction materials [18]. Traditional brick manufacturing heavily relies on clayey soil, contributing to soil depletion and habitat disruption. Researchers have explored alternative materials to partially replace clay, aiming to improve the sustainability of brick production [19]. Studies have investigated the influence of adding polystyrene beads to bricks on various properties, such as compressive strength, thermal conductivity, and density [20]. Understanding these effects is crucial for assessing the feasibility and practicality of incorporating polystyrene into brick manufacturing. Several researchers have conducted life cycle assessments to evaluate the overall environmental impact of using polystyrene in construction materials [21]. These studies provide valuable insights into the holistic sustainability of such practices. Polystyrene-based bricks have gained attention for their potential to reduce the environmental footprint associated with traditional brick manufacturing processes. It emphasized the significance of repurposing polystyrene waste in construction materials, diverting it from landfills, and mitigating the environmental impact of this non-biodegradable material. A key aspect addressed is the life cycle assessment of polystyrene bricks, offering a holistic view of their environmental impact. The study reveals a promising reduction in carbon emissions and resource consumption compared to conventional brick production methods, highlighting the potential of polystyrene as a sustainable alternative. Critics often raise concerns about the structural integrity and durability of polystyrene-based bricks. However, provides valuable insights into the structural and thermal performance of bricks modified with polystyrene. Their findings indicate that these bricks exhibit favorable thermal insulation properties, contributing to enhanced energy efficiency in buildings. It explored the influence of polystyrene content on the compressive strength of lightweight bricks, addressing concerns related to mechanical properties. Collectively, these studies contribute to the growing body of knowledge on the structural characteristics and performance of polystyrene-based bricks. Understanding the current state of research and industry practices is vital for gauging the feasibility of the widespread adoption of polystyrene in brick production [22, 23].

Innovative approaches were explored to transform polystyrene waste into building blocks, showcasing the potential for repurposing this material [24]. Furthermore, it was explored that the influence of polystyrene bricks on indoor air quality contributes to the overall understanding of the indoor environmental benefits associated with this material [25]. Researchers Gupta delve into the socio-economic impacts of introducing polystyrene bricks in developing regions, considering factors such as employment, affordability, and community engagement. This socio-economic perspective is crucial for ensuring that the adoption of polystyrene aligns with broader sustainable development goals [26].

This research aims to produce eco-friendly bricks utilizing polystyrene beads to investigate the influence on the physical, mechanical, and thermal insulation properties. This study also focuses on the waste landfills issue and environmental protection, ultimately trying to provide relief from different types of pollution and improving the quality of the air, which will prove helpful in disease control management programs. The following are the objectives of this research work.

The following are the objectives of this investigation.

- To investigate the influence of the EPBs on the engineering properties of the bricks.
- To study the thermal insulation properties of the bricks incorporating EPBs.
- To visualize the XRD pattern of the EPBs bricks.
- To highlight the impact of EPB waste on the microstructure of the bricks.
- To clean the environment by utilizing the expanded polystyrene beads waste.

## II. MATERIAL AND METHOD

The following are the materials used in this research work.

### A. Soil (clay)

A production unit needs to have good quality clay to deliver a solid brick that can be utilized in construction. Certain types of clay are bad for making fired bricks. For instance, the clay utilized by a potter to make bowls and cups isn't useful for making bricks because it has a high shrinkage rate, which makes the bricks crack during drying [27]. The soil sample was collected for use in admixture assessment. The soil utilized for the EPB bricks production is of the group CL-ML according to the Unified Soil Classification System (USCS). The local soil properties were according to ASTM standards, having a moisture content of about 6.62% with the appropriate property of plasticity, which was considered good for the molding of the bricks.

### B. Polystyrene

Polystyrene (PS) plastic is an obvious thermoplastic that is on hand as both an average strong plastic too as well inside the form of a rigid foam fabric [28]. Polystyrene plastic is normally utilized in an expansion of client gadgets applications and is likewise particularly valuable for commercial packaging. The fabric is to a few degrees disputable amongst environmentalists when you consider that it's miles sluggish to biodegrade and is step by step present as of doors muddle (especially within the sort of foam floating in streams and the ocean). The sturdy kind of polystyrene is generally utilized in medical gadget packages like test tubes or Petri dishes, or everyday things like housing on your smoke alarms, the case you applied to purchase your CDs in, and frequently used as a box for ingredients like yogurt.

Polystyrene is typically (yet not continually) a photopolymer, suggesting that it is the result of just the monomer styrene blending in with itself. Contingent on the kind of polystyrene, it is possibly ordered as a "thermoplastic" or a "thermoset" fabric. The name has to do with the way the plastic responds to warmness. Thermoplastic substances develop to be liquid at their liquefying point at 210-249 degrees Celsius on account of polystyrene, yet they start to take the path of least resistance at their glass progress factor at 100 levels Celsius for polystyrene.

Three sizable kinds of polystyrene include polystyrene froth, general polystyrene plastic, and polystyrene film. Among the different types of froth are Expanded Polystyrene (EPS) and Expelled Polystyrene (XPS). EPS comprises the most extreme choice and essential kinds of polystyrene to incorporate Styrofoam and pressing peanuts. XPS is a higher thick froth routinely used in projects like compositional designs. A couple of kinds of polystyrene plastic are copolymers. Usually, polystyrene is non-toxic and unscented. Even as that could lead you to consider it is completely included, a few investigations have discovered "ability health effects from polystyrene foam food packaging related with its manufacturing, and with the filtering of a number of its chemical additives into foods and drinks." observe: polystyrene is combustible and like other herbal compounds; it emits carbon Dioxide ($co_2$) and water when it is burned. [9]

### C. Water

Water is a fundamental object of brick as it is utilized for the industrialization of brick since it assists in associating all of the uncooked fabric to give a proper blend. Certainly, the versatility of water as a dissolvable is simple to residing organisms. The water used in this research study was normal tap water.

The methodology of this research study is as follows:

### D. Sample collection

Soil sample was collected for the research study in the following manner.

- The soil was collected from Hayatabad Peshawar from a preliminary pit of 3x3ft, samples were collected from 4 preliminary pits, and all the samples utilized during this examination were molded within the laboratory according to the available standard procedures. For the laboratory testing program, polystyrene was considered a competitor stabilizer to treat/balance out soil.
- Polystyrene beads were later collected from the polystyrene manufacturing producing industry. The material utilized for the adjustment and modification study is Polystyrene. The soil was blended in with material for which there were sensible desires for improved engineering properties.
- Brick samples were cast with EPS waste of 0%, 4%, 8%, and 12%, respectively.
- Investigatory tests were performed on the brick samples with different percentages, i.e., Scanning Electronic Microscopy (SEM), X-ray Diffraction (XRD), Compressive Strength, Thermal Conductivity, Atterberg Limits, Water Absorption, etc.
- Results of the different tests were made among all the different samples, which are discussed in the next section.

## III. RESULTS AND DISCUSSION

This section includes the results of conventional (controlled) samples and modified specimens prepared by replacing different percentages of expanded polystyrene beads. The tests performed were the liquid limit, plastic limit, specific gravity, direct shear test, compressive strength, water absorption, XRD, SEM, and thermal conductivity. Different percentages of Polystyrene (beads) are 0%, 4%, 8%, and 12%. The results of conducted tests on virgin and modified samples of the bricks will be discussed in this section.

### A. Atterberg limits

The following section describes the outcomes of the consistency limits, i.e., Liquid Limit (LL), Plastic Limit (PL), and Plasticity Index (PI).

#### *1) Liquid Limit (LL):*

Following are the results of the liquid limit of the pure soil sample molded to form bricks. Total weight of sample = 140g

TABLE I
LIQUID LIMIT (LL) TEST RESULTS OF THE VIRGIN SOIL

| Container | Container Weight, W1(g) | Container Weight + Wet Soil, W2(g) | Container Weight + Dry Soil, W3(g) | Moisture Content % | No. of Blows |
|---|---|---|---|---|---|
| 1 | 21.23 | 143.4 | 71.51 | 27.25 | 34 |
| 2 | 21.23 | 142.7 | 71.25 | 26.12 | 27 |
| 3 | 21.23 | 143.9 | 72.42 | 27.82 | 21 |
| Liquid Limit (LL) % | | | | 26.60 | |

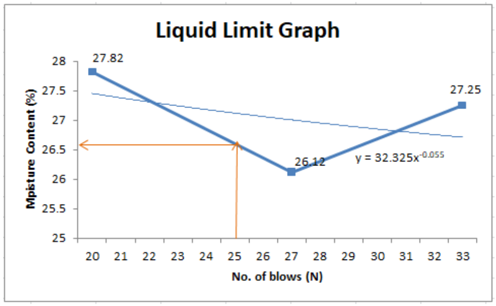


Fig. 1. Plot of moisture content (%) vs. no. of blows for liquid limit test

### 2) *Plastic Limit (PL) test result:*

The result of the Plastic Limit (PL) with soil having 0% polystyrene beads is given, as shown in the table.

TABLE II
PLASTIC LIMIT (PL) TEST OUTCOME OF THE PURE SOIL SAMPLE

| Serial No. | Container weight, W1(g) | Container weight +Wet Soil, W2(g) | Container weight + dry Soil, W3(g) | Moisture Content |
|---|---|---|---|---|
| `1 | 26.52 | 29.92 | 21.59 | 18.88 |
| 2 | 24.25 | 27.44 | 26.48 | 17.80 |
| 3 | 27.76 | 31.21 | 30.69 | 17.34 |
| Plastic Limit (PL) (%) | | | 18.90 | |

### 3) *Plastic index:*

The result of the plasticity index of the virgin soil is given by subtracting the value of LL from PL and is as follows. Table 3: Plasticity Index (PI) result of the soil sample

TABLE III
PLASTICITY INDEX (PI) RESULT OF THE SOIL SAMPLE

| Serial No. | Liquid Limit | Plastic Limit | Plasticity Index (LL-PL) |
|---|---|---|---|
| 1 | 26.60 | 18.90 | 7.07 |

Determining the liquid and plastic limits is important for comprehending the workability and behavior of the lightweight brick masonry units in the research "Development and Assessment of the Mechanical Properties of the Lightweight Brick Masonry Unit Utilizing Expanded Polystyrene Beads." The soil's capacity to be molded and shaped during the brick-making process is indicated by the liquid limit, which is the moisture level at which the soil changes from a plastic to a liquid condition. The plastic limit, on the other hand, indicates the moisture content at which soil can no longer be molded without breaking, offering information on the shrinkage and plasticity properties of the clay. These variables are crucial for maximizing the lightweight bricks' composition, guaranteeing safe handling during the production process, and ultimately affecting their structural and mechanical performance.

## B. Specific gravity

Following are the results of the specific gravity test.

TABLE IV
OUTCOMES OF THE SPECIFIC GRAVITY TEST OF THE SOIL SAMPLE

| S No. | Observation Number | 1 | 2 | 3 |
|---|---|---|---|---|
| 1 | Weight of Empty Pycnometer (gram) | 209 | 185 | 183 |
| 2 | Weight of Pycnometer + Soil Sample (gram) | 409 | 385 | 383 |
| 3 | Weight of Pycnometer + Soil + Water (gram) | 1432.70 | 1399.90 | 1415.25 |
| 4 | Weight of Pycnometer + Water (gram) | 1314.3 | 1326.3 | 1335 |
| 5 | Weight of Soil Sample (gram) | 200 | 200 | 200 |
| 6 | Weight of Equal Volume of Water (gram) | 1160.3 | 1150.3 | 1127.1 |
| 7 | Specific Gravity | 2.39 | 2.36 | 2.29 |
| Average Specific Gravity at 20°c | | | 2.34 | |

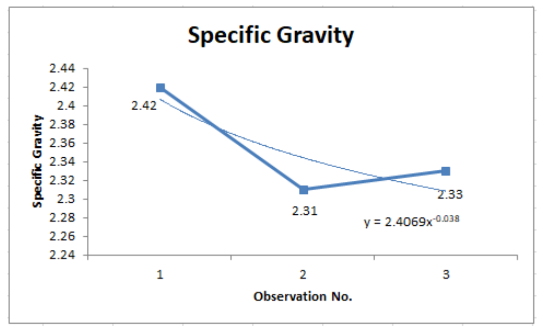


Fig. 2. Specific gravity values against each observation number

Understanding the density and composition of the lightweight brick masonry units in this study is largely dependent on the specific gravity measurement. The ratio of a substance's density to that of a reference substance, typically water, is known as specific gravity. Researchers may evaluate the relative densities and contributions to the total density of the lightweight bricks made from expanded polystyrene beads, cement, and clay by measuring the specific gravity of these materials. This data is necessary to assess the thermal insulation qualities and structural soundness of lightweight brick masonry units, as well as to optimize the mix design and ensure appropriate material distribution.

## C. Direct shear test

The results of the direct shear test of different soil samples are discussed in this section and are shown in the table and figure.

TABLE V
OUTCOMES OF THE DIRECT SHEAR TEST OF THE VIRGIN SOIL AND EPB MULTIPLE CONTENTS

| Serial No. | Soil + Additive (EPBs) (%) | Cohesion C | Angle of Internal Friction (φ) |
|---|---|---|---|
| 1 | 100 + 0 | 0.081 | 25.32 |
| 2 | 96 + 4 | 0.064 | 27.22 |
| 3 | 92 + 8 | 0.049 | 29.76 |
| 4 | 88 + 12 | 0.023 | 31.93 |

It's interesting to note that cohesiveness values fall noticeably when the proportion of polystyrene beads in soil used to make bricks rises. This implies that the soil's resistance to shear pressures is being impacted by the addition of polystyrene beads. Comprehending the mechanisms underlying this decline in cohesiveness may yield significant knowledge for streamlining the brick production process.

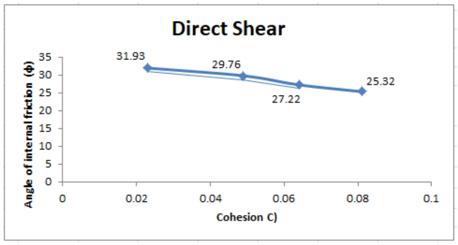


Fig. 3. Deviation of the graph amongst the angle of internal friction and cohesion for numerous soil samples

One interesting discovery is the simultaneous increase in internal friction levels as the amount of polystyrene beads increases. This suggests that adding polystyrene to the soil increases its resistance to slide and deformation. Investigating the particle interactions and soil structure alterations that result in this increased internal friction would be intriguing since it may boost the bricks' overall stability.

### D. Compressive strength

The results of the compressive strength test of different soil samples are discussed in this section and are shown in the table and figure.

TABLE VI
COMPRESSIVE STRENGTH TEST RESULTS ON BRICKS WITH CONTENTS OF EPBS

| Serial No. | Soil + Additive (EPBs) (%) | Dimension of Brick (cm) | Maximum Load (KN) | Compressive Strength (N/mm$^2$) |
|---|---|---|---|---|
| 1 | 100 + 0 | 22×10.5×7.2 | 298.12 | 13.81 |
| 2 | 96 + 4 | 22×10.5×7.2 | 198.47 | 8.62 |
| 3 | 92 + 8 | 22×10.5×7.2 | 126.17 | 6.90 |
| 4 | 88 + 12 | 22×10.5×7.2 | 90.642 | 3.51 |

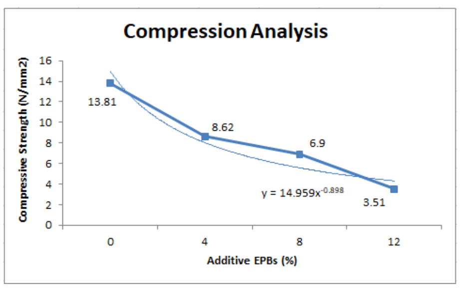


Fig. 4. Compressive strength values against the additive percentages

The presence of polystyrene beads in the soil matrix may have caused the development of voids or weak areas, which might account for the drop in compressive strength. It would be beneficial to examine the microstructural alterations and how they affect load-bearing capability. Investigating alternative techniques of reinforcing or manufacturing process modifications that might offset the noted decline in compressive strength is crucial.

### E. Water absorption test

Following are the outcomes of the water absorption experiment performed to analyze the influence of the EPB content on the water absorption percentage of the bricks.

TABLE VII
RESULTS OF WATER ABSORPTION OF BRICKS WITH USAGE OF EPBS CONTENT AS AN ADDITIVE

| Serial No. | Soil + Additive (EPB) (%) | Weight of Wet Brick, W2 (Kg) | Weight of Dry Brick, W1 (Kg) | Water Absorption (%) |
|---|---|---|---|---|
| 1 | 100 + 0 | 3.35 | 2.90 | 13.03 |
| 2 | 96 + 4 | 3.20 | 2.80 | 14.28 |
| 3 | 92 + 8 | 2.89 | 2.50 | 15.60 |
| 4 | 88 + 12 | 2.77 | 2.39 | 16.31 |

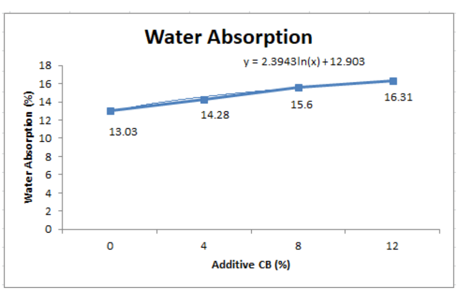


Fig. 5. Graphical representation of additive percentage with water absorption

After curing, the bricks are weighed after total drying. The water absorption and compressive strength tests were performed on the bricks. A. Weight Analysis: The bricks are weighed after total drying. The weights of bricks (0%, 4%, 8%, and 12%) are weighed and contrasted with the weights of conventional burnt clay bricks. The weight decrease is completed by keeping the weight of burnt clay brick as a kind of perspective. The aftereffects of weight reduction are given in the table below.

TABLE VIII
WEIGHT ANALYSIS OF WATER ABSORPTION

| Sample (EPBs Content) | Weight per Brick (kg) | Weight Reduction (%) |
|---|---|---|
| 0% | 3.20 | 0 |
| 4% | 2.80 | 12.50 |
| 8% | 2.50 | 21.87 |
| 12% | 2.39 | 25.31 |

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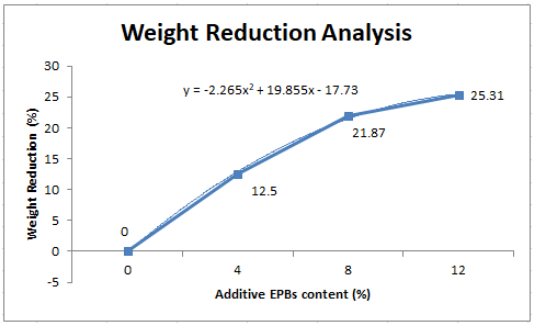


Fig. 6. Weight analysis of the brick due to water absorption

## F. Thermal conductivity test

Outcomes of the experimental performance of the thermal conductivity test are given in the tables and graphically presented by a graph as under.

TABLE IX
THERMAL CONDUCTIVITY TEST ANALYSIS ON THE BRICKS WITH EPB CONTENTS

| Serial No. | Soil + Additive (EPB) (%) | Density ($kg/m^3$) | Thermal Conductivity ($Wm\text{-}1^{k-1}$) | Decline of Heat Conductivity (%) |
|---|---|---|---|---|
| 1 | 100 + 0 | 1832 | 1.23 | 0 |
| 2 | 96 + 4 | 1655 | 0.72 | 46 |
| 3 | 92 + 8 | 1491 | 0.49 | 40 |
| 4 | 88 + 12 | 1337 | 0.25 | 49 |

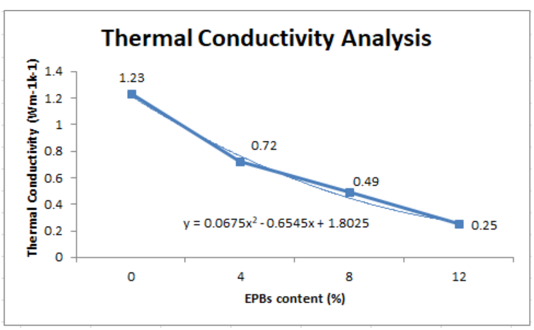


Fig. 7. Thermal conductivity against EB contents

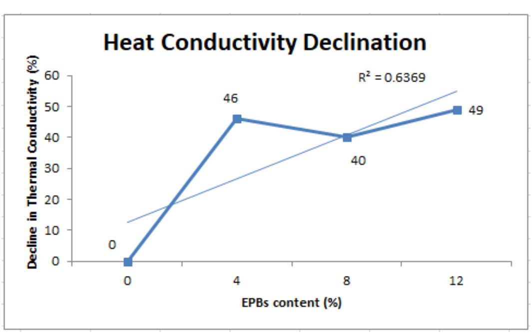


Fig. 8. Reduction of thermal conductivity against each EPB content

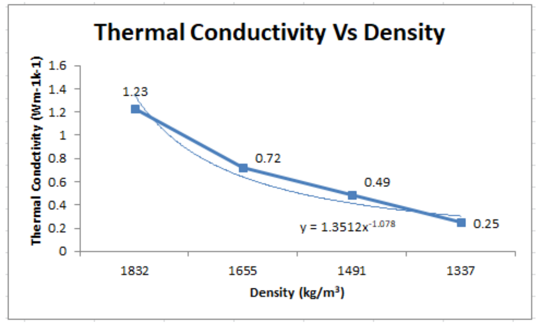


Fig. 9. Reduction of thermal conductivity against each EPB content

The reduction in heat conduction is consistent with what is expected when insulating with polystyrene beads. This result implies that an increase in polystyrene content makes the soil-brick composite more heat resistant. It makes it possible to create bricks with better thermal performance, which is especially important in areas with high temperatures.

## G. Scanning Electron Microscopy (SEM)

Following are the results of the experimental performances of the SEM test based on multiple contents of the expanded polystyrene beads (EPBs), as shown in the images/figures.

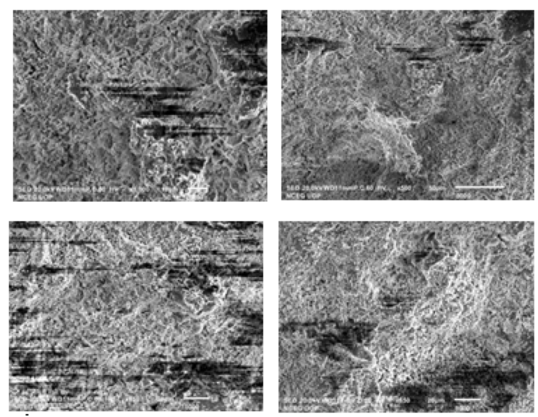

Fig. 10. : SEM result of the bricks with 0% EPB content

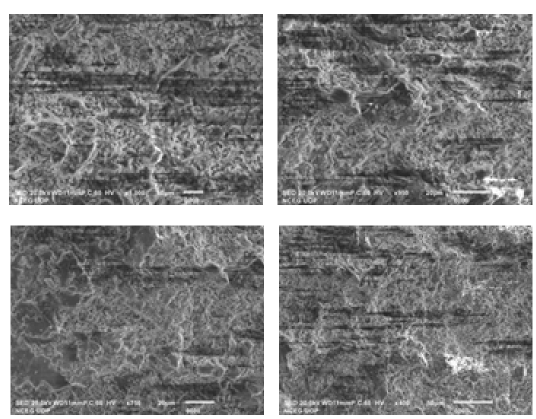

Fig. 11. SEM result of the bricks with 4% EPB content

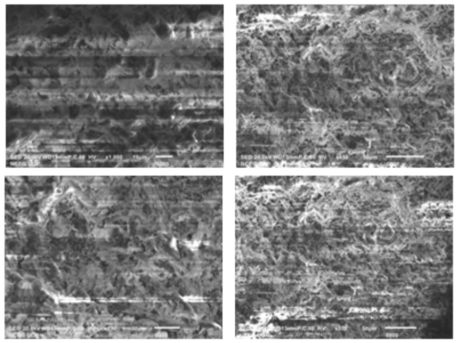

Fig. 12. SEM result of the bricks with 8% EPB content

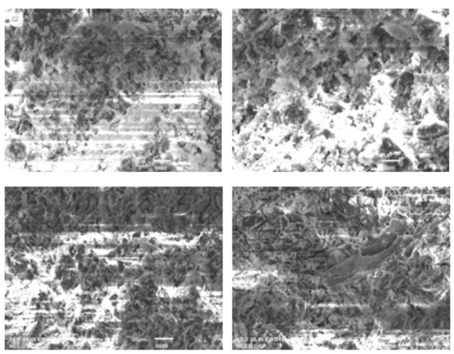

Fig. 13. SEM result of the bricks with 12% EPB content

The level of interlocking between soil particles and polystyrene beads as the content increases was shown by microstructural investigation using SEM. It has been investigated and found that the beads serve as reinforcement, preventing any discontinuities in the matrix. Furthermore, the addition of polystyrene was shown to have the capacity to modify the surface features of the soil particles, which added to a more thorough knowledge of the material's behavior. No clusters with increased polystyrene beads content have formed; instead, they have dispersed uniformly, reducing the soil's porosity and the amount of spaces between soil particles as a result of reduced bonds.

### H. X-ray Diffraction (XRD)

The results of the X-ray diffraction test against the east of the multiple EPB content are shown in this image as follows.

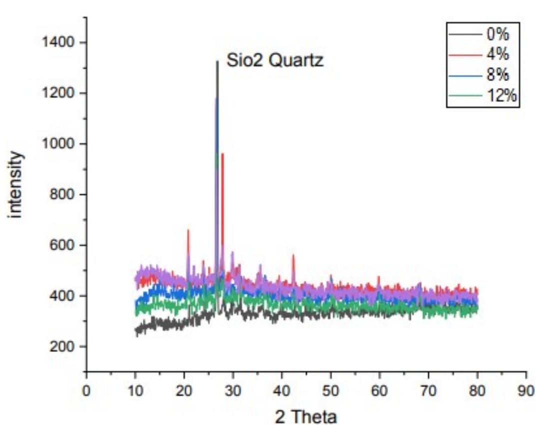


Fig. 14. Graphical outcome of the X-ray diffraction test

The addition of polystyrene beads caused phase changes and the creation of new crystalline phases, as seen by the XRD data. It detected the alterations that are essential for evaluating the bricks' long-term stability and durability. To get a comprehensive knowledge of how the composition of the material affects its macroscopic characteristics, it would be interesting to link these results with those of other tests.

## IV. CONCLUSION

The test demonstrated that by increasing the polystyrene beads, the compressive strength of the blocks reduces; however, the water absorption increments. Therefore, it is important to determine ways to improve and optimize soil so that by decreasing the thickness, the strength of the brick does not decrease significantly. Replacing even 4% of polystyrene beads keeps the compressive strength of the resulting bricks as appropriate for load-bearing conventional bricks as per the standard. The thermal conductivity of lightweight polystyrene bricks made of 4% polystyrene is ¼ of that of normal bricks, so it causes a significant impact on energy saving in the building.

Polystyrene bricks give great workability and could, without much of a stretch, be compacted and finished. The sample 4% (9.57 N/mm2) has possessed identical strength as burnt clay bricks, which come under the second (2nd) class brick classification. Another lightweight specimen (8% and 12%) demonstrated a higher result than a third (3rd) category brick (higher than 3.5 N/mm2). Initial findings have indicated that the lightweight bricks utilizing Polystyrene beads have a desirable strength to be an alternative construction material for the construction of walls. The strength of lightweight bricks utilizing Polystyrene beads is low and causes pores in the bricks. This resulted from an increase of polystyrene beads all through the specimen caused by the air entraining in the admixture. Lightweight bricks utilizing polystyrene beads decrease the dead load of the structure, which gives it better stability in seismic circumstances.

### A. Implication and limitations

There are important ramifications for the building sector from the creation and evaluation of the mechanical characteristics of lightweight brick masonry units made from expanded polystyrene beads. The goal of the project is to produce lightweight bricks with improved thermal insulation qualities by adding expanded polystyrene beads into the brick-making process. This invention may result in lower construction costs, more energy-efficient structures, and better structural performance in seismically active areas.

It is essential to acknowledge the limits of this research, though. First off, although the mechanical characteristics of lightweight bricks may be evaluated in a controlled laboratory setting, there is still much to learn about how well these bricks will function in a variety of real-world settings over time. Additional research is necessary to determine factors like long-term durability, weather resilience, and compatibility with various building methods. Furthermore, because building procedures, climate, and materials vary, the study's conclusions could not hold true in all situations and geographical areas. A major factor in influencing the viability and acceptance of lightweight brick masonry units is local laws and building rules.

In conclusion, even though the creation of lightweight bricks made of expanded polystyrene beads offers encouraging prospects for environmentally friendly building, careful evaluation, verification, and contextual adaptation are required to guarantee their efficient application and long-term sustainability in the building sector.

### B. Recommendations

A number of suggestions may be made in light of the study's findings to improve the use and efficacy of lightweight brick masonry units:

Enhancement of Bead Structure: Examine the effects of varying proportions of expanded polystyrene beads to conventional brick ingredients (cement and clay) on the mechanical characteristics and thermal insulation of lightweight bricks. Bricks with an enhanced strength-to-weight ratio and thermal performance may result from this optimization.

#### *1) Extended durability research:*

To evaluate the performance of lightweight brick masonry units across a range of environmental circumstances, such as exposure to moisture, temperature changes, and chemical degradation, conduct long-term durability tests. This will give important information on how long these brick structures will last and how much upkeep they'll need.

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