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(Research Article)

Development of lightweight building blocks using expanded polystyrene

Moudud Ahmmed [1,*], Zainul Abedin [2], Subrata Paul [3], Golam Kibria Bhuiyan [3], Hafijur Rahaman [1], Mohammad Afzal Hossain [1], Monirul Islam [3] and Arafat Ullah khan [3]

[1] *Workshop Machinery and Maintenance Division (WMM), Bangladesh Rice Research Institute, Gazipur, Bangladesh.*
[2] *Department of Farm Structure & Environmental Engineering (FSEE), Bangladesh Agricultural University, Mymensingh, Bangladesh.*
[3] *Farm Machinery and Postharvest Technology Division (FMPHT), Bangladesh Rice Research Institute, Gazipur, Bangladesh.*

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Abstract

This study aimed to develop lightweight building blocks using Expanded Polystyrene (EPS) with varying percentages, assess their properties, including density, water absorption, porosity, and compressive strength, and evaluate the unit cost of the blocks. The heat-passing rate of the blocks was also investigated. EPS blocks were produced at the Concrete and Materials Testing Laboratory in the Farm Structure and Environmental Engineering Department, Bangladesh Agricultural University, Mymensingh. Local sand and ordinary Portland cement were utilized, with the EPS bead sizes ranging from 2.36mm to 6.35mm. Five different percentages of EPS beads (0%, 5%, 10%, 15%, and 20%) were selected for each block, and the cement-to-sand ratio was 1:4. A total of 75 EPS blocks were fabricated and cured in water for 28 days. The results showed that the density was highest for 0% EPS blocks (2139.75 kg/m^3) and lowest for 20% EPS blocks (1699.08 kg/m^3). Water absorption was most insufficient for 0% EPS blocks (4.39%) and highest for 20% EPS blocks (9.07%). The porosity was highest for 20% EPS blocks (14.37%) and lowest for 0% EPS blocks (6.74%). The heat passing rate was minimal for 0% EPS blocks and highest for 20% EPS blocks. Compressive strength was highest for 0% EPS blocks (13.37 MPa), moderate for 10% EPS blocks (10.87 MPa), and lowest for 20% EPS blocks (8.94 MPa). The unit cost of 100 blocks was highest for 0% EPS blocks (15.18 USD) and lowest for 20% EPS blocks (13.28 USD). Overall, the EPS blocks are recommended for construction due to their durability and compressive strength.

Keywords: Expanded Polystyrene; Blocks; Strength; Cost

1. Introduction

The demand for construction materials is experiencing a significant surge due to increased global development activities, and this trend is expected to impact the economic systems of nations substantially. Bangladesh, like other Asian countries, is also striving for rapid development, leading to a high demand for building supplies in the domestic market. Researchers and engineers need to explore alternative building materials to sustain development activities and reduce costs. With the growing need for a new ecological balance, there has been increased research into adopting more environmentally friendly materials, leading to the utilization of plastic-based products in the construction industry. One such product that has emerged as an alternative to traditional building materials is expanded polystyrene (EPS).

The issue of environmental protection is becoming increasingly important worldwide, prompting actions in all countries to mitigate the impact of human activities on the environment. Careful selection of building materials, particularly insulation, is being prioritized in the building and construction sectors to address these challenges [1]. Therefore, incorporating eco-friendly materials like EPS into new and upgraded construction technology systems can

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[*] Corresponding author: Moudud Ahmmed

significantly impact the environment [2]. The construction industry, predominantly reliant on bricks as a primary building material, has witnessed a growth rate of approximately 5.6% per year between 1995 and 2005, with the brick sector expected to maintain a growth rate of 2-3%. Bangladesh alone produces around 17.2 billion burnt clay bricks annually, contributing to a market value of Tk.83 billion [3].

Brick-making is a vital industry in Bangladesh, employing over 1 million people and operating around 5,000 kilns. It contributes approximately 1% to the nation's GDP (The World Bank, ESMAP-2011). Enormous quantities of clay bricks require 45 million tons of clay, 3.5 million tons of coal, and 2 million tons of firewood. Energy dominates the brick industry in Bangladesh- and pollution-intensive Fixed Chimney Kiln (FCK) technology. On average, 18-22 tons of coal are needed per 100,000 bricks produced in most working kilns [3]. The combustion of coal in these kilns releases pollutants into the atmosphere, impacting human health agricultural productivity, and exacerbating global warming and climate change. The annual CO_2 emissions from brick production in Bangladesh alone amount to 9.8 million tons [5]. Expanded Polystyrene (EPS) is a lightweight material commonly used as a lightweight aggregate in producing non-structural lightweight concrete. This waste material has been utilized since the 1950s and is considered one of the most effective insulation materials. The properties of polystyrene aggregate concrete, such as compressive strength, elastic modulus, drying shrinkage, and creep, vary depending on the density of the concrete [4].

Lightweight blocks may have lower or higher compressive strength than traditional ones [5]. EPS is utilized to determine whether there has been any improvement in the compressive strength of partnerships [21]. Based on their research on various mix proportions for polystyrene concrete, the circular shape of EPS beads contributed to the mix's workability and EPS beads that came into direct contact with heated surfaces shrunk, causing the formation of voids in the concrete [3]. Compressive strengths of test samples are generally between 0.28 MPa and 4.22 MPa, and the thermal conductivity ranges from 0.073 to 0.3 W/(m °C) based on the average density of polystyrene concrete, according to a study on the thermal insulation qualities of polystyrene bricks [6].

Expanded polystyrene (EPS) offers numerous advantages in building construction compared to traditional materials, contributing to a more sustainable future. EPS is a robust and versatile material that provides excellent insulation properties. With 98% of its structure consisting of air, EPS maintains its thermal characteristics throughout its lifespan. It is available in a wide range of shapes and sizes, offering flexibility in design and construction. Expanded polystyrene in buildings brings several benefits, including enhanced thermal insulation, reduced energy consumption, and improved overall sustainability [7].

Lightweight concrete, incorporating EPS beads, is used to reduce the dead load of structures, which is crucial in minimizing project costs. EPS beads have been commonly used in engineering applications since the 1950s. Lightweight concrete with polystyrene aggregate has unit weights ranging from 1200 to 2000 kg/m3. The lower the thermal conductivity, the better the thermal insulation properties of the concrete. EPS beads are commonly used as an aggregate in both mortar and concrete, contributing to the lightweight and insulating characteristics of the material [7]. The compressive strength of lightweight blocks can vary, either lower or higher than traditional blocks. EPS is utilized in studies to assess improvements in the compressive strength of the partnerships. Researchers have found that the circular shape of EPS beads enhances the workability of the concrete mix, and when EPS beads come into direct contact with heated surfaces, they shrink, creating voids in the concrete. The compressive strengths of test samples typically range from 0.28 MPa to 4.22 MPa, and the thermal conductivity varies from 0.073 to 0.3 W/ (m °C) based on the average density of the polystyrene concrete. These findings demonstrate the thermal insulation qualities of polystyrene bricks [6].

Moreover, clay extraction for traditional brick manufacturing often involves unplanned brickfields and topsoil depletion, resulting in the loss of approximately 42,000 acres of agricultural land each year. Continuing these practices poses a risk to our food security. In light of this pressing issue, research has been conducted to explore alternatives to clay bricks, one of which is the thermal block. The thermal block is a concrete block incorporating expanded polystyrene (EPS) to enhance thermal resistance and reduce overall weight. The league is cast with cement mortar over the EPS and allowed to cure for a specified period. This approach offers cost-effectiveness, sustainability, and environmental friendliness since it eliminates the need for burning. Furthermore, walls constructed with thermal blocks provide a comfortable indoor environment in both summer and winter. The lightweight nature of these blocks not only saves on structural costs but also makes them suitable for multi-story buildings from an earthquake standpoint.

Regular aggregate can be partially or wholly replaced with lightweight aggregate in lightweight concrete, depending on the desired density and strength requirements [8]. The current study uses expanded polystyrene (EPS) beads as lightweight aggregates in mortars and concrete that incorporate silica fume as an additional cementitious material [9]. Since the 1950s, expanded polystyrene (EPS), a lightweight polymer, has found extensive use in various engineering applications, particularly in the packaging industry. It is widely employed in everyday applications that require lightweight thermal insulation and shock absorption properties [10]. The EPS beads are derived from recycled polystyrene waste and can be utilized to create lightweight concrete with excellent insulation properties. The recycled polystyrene is processed back into EPS beads or regrind material and mixed with additives and cement to form lightweight concrete blocks. Typically, the composition of polystyrene concrete includes recovered polystyrene granules, cement silica aggregate, and modifying agents such as setting accelerators [8] .

Another significant advantage of using concrete blocks in construction is their lightweight nature, reducing the need for structural steel and concrete commonly employed in constructing concrete walls [11]. Additionally, using lightweight concrete blocks minimizes labor and other building materials requirement, resulting in cost savings and increased efficiency in the construction process [12]. By implementing lightweight concrete blocks, fast and sustainable building solutions can offer durability, stability, and excellent thermal properties.

Objectives

This study has three main objectives. Firstly, it aims to determine the physical properties and heat passing rate of Expanded Polystyrene (EPS) blocks. Secondly, the study seeks to compare the compressive strength of blocks prepared with different percentages of EPS. Lastly, the study aims to evaluate the cost-effectiveness of the developed blocks. These objectives collectively contribute to a comprehensive understanding of EPS blocks' physical properties, structural strength, thermal performance, and cost-effectiveness. The findings of this study will offer valuable insights for their practical application in the construction industry, aiding in the decision-making process for selecting appropriate building materials.

2. Material and methods

2.1. Cement

In engineering construction, cement plays a crucial role as a binding material. Regular Portland cement (Brand: Tiger) was used for this experiment. The cement exhibited a uniform grey color and was free from any lumps or impurities. Expanded Polystyrene (EPS) blocks were constructed using regular Portland cement (Type-1) that met the specifications of passing an ASTM 200-micron sieve.

2.2. Sand

Sand is essential in engineering construction due to its versatile nature and wide range of applications. In concrete work, it is commonly referred to as a fine aggregate. The characteristics of sand grains can vary, with some being sharp, angular, or spherical[11]. In the district of Mymensingh, high-quality river sand is readily available. For the formation of blocks in this experiment, relatively coarse sand with a fineness modulus of 1.44, obtained from a nearby river source, was used.

2.3. Expanded Polystyrene

Figure 1 Expanded Polystyrene

Figure 2 Mixing cement–sand-expanded polystyrene

Expanded Polystyrene (EPS) [Figure 1] is a lightweight and rigid foam material produced through the polymerization of styrene. It is known for its versatility and durability and has excellent insulation properties [13]. This experiment utilized expanded polystyrene with sizes ranging from 2.36 mm to 6.35 mm.

2.4. Method of block construction

Successful engineering construction requires a combination of skilled and experienced workmanship and the availability of on-site or nearby necessary building supplies. It is crucial to ensure the quality of construction throughout the process. In the case of forming expanded polystyrene blocks, the following steps were followed:

Mixing cement, sand, and expanded polystyrene appropriately: The required amounts of cement, sand, and expanded polystyrene were carefully measured and mixed in the correct ratios. This step is crucial to ensure a well-balanced and uniform mixture that will result in the desired properties of the blocks.

Formation of blocks: The prepared mixture was then shaped into blocks using molds or formwork. Care was taken to ensure the blocks were properly compacted and formed with consistent dimensions.

Curing: Once the blocks were formed, they were subjected to a curing process. Curing involves providing optimal conditions, such as adequate moisture and temperature control, to allow the blocks to gain strength and stability over time. This step is essential for developing the desired properties of the blocks.

These general steps provide an overview of the block construction process using expanded polystyrene. It is essential to follow these steps meticulously to achieve high-quality construction results.

2.5. Mixing cement, sand, and polystyrene in the right proportion

A sand-to-cement ratio of one to four was used to ensure the required design strength and consistency of the mortar. Various percentages of expanded polystyrene (EPS) were incorporated, including 0%, 5%, 10%, 15%, and 20%. The process involved spreading the sand uniformly on a non-porous surface to the desired thickness after thorough sieving. Following this, the cement was applied on top of the sand. A water-cement ratio of 0.50 was used in this study. The components of each sample were accurately measured in a dry environment and mixed thoroughly before casting. The required amount of water was then added, and the mixture was worked until it reached a consistent state. The prepared mixture [Figure 2] was cast into brick molds pre-coated with oil to facilitate easy release from the molds. The dimensions of the brick molds used were 10″×5″×3″. After 24 hours, the samples were removed from the molds and placed in a tank for the desired curing period.

2.6. Formation of block

An iron mold was placed on a polythene sheet in the process described. A concrete mixture with a precise ratio of 1 part cement to 4 parts sand was poured into the mold. The concrete was then compacted carefully and thoroughly to remove any air gaps or voids. The top of the mold was levelled using a wooden float, ensuring a smooth surface. The concrete mixture used in this process was prepared manually. According to Figure 2, the dry components, including cement, sand, and expanded polystyrene, were combined first. Then, water and EPS beads were added and mixed. This blending process ensured a consistent combination, as depicted in Figure 2.

They were cleaned and lubricated beforehand to prevent the molds from sticking to the concrete. Once prepared, the fresh concrete mixture was manually pressed into the molds until filled. After compaction was finished, the surface of the concrete was levelled, and any excess mortar was scraped off from the mold using a trowel. The filled molds were undisturbed for 24 hours to allow the concrete to harden. After this curing period, the molds were removed, resulting in molded concrete samples. The molded pieces were placed in a curing tank filled with potable water to ensure proper curing. Finally, blocks made of expanded polystyrene were successfully created through this process.

2.7. Curing

They are obtaining high-quality hardened concrete that has been adequately cured in a suitable environment. Curing refers to enhancing the hydration of cement and involves controlling both temperature and moisture passage within the mortar or concrete [16]. Proper curing plays a significant role in the development of concrete strength. In this case, the blocks were removed from the molds one day after being cast. The blocks were covered with jute sacks throughout the process to ensure proper curing. This covering helps to maintain moisture levels and creates a suitable environment for the concrete to cure effectively. To keep the blocks in a moist state, water was utilized for 28 days. During this period, specific conditions were maintained. The relative humidity was adjusted to the 87-95% range, while the room temperature was kept at 28-30 °C. These controlled conditions contribute to the optimal curing of the concrete, promoting its strength development. By following these careful curing practices, the concrete blocks can achieve the desired level of quality and strength.

2.8. Testing of Expanded Polystyrene Block

The blocks were tested for (1) Density, (2) Porosity, (3) Water absorption, (4) Compressive strength (5) Heat Passing Rate. These tests were conducted in the Concrete and Materials Testing Laboratory of the Department of Farm Structure and Environment Engineering, Bangladesh Agricultural University.

2.8.1. Density

A block's density is calculated by dividing its total weight by volume. Each block was initially measured using a balance. Then, the density was measured by using the following expression:

$$\text{Density} = \text{weight}/\ \text{volume}$$

Here,

The volume of solid block=10″×5″×3″=150in^3= 0.002458 m^3

So, density of block = Weight/0.002458 (kg/m^3)

The average density of the block was calculated for each percentage of expanded polystyrene.

2.8.2. Porosity

The mortar porosity test was performed on block specimens. When the cure had been 28 days, the test was run. The samples were weighed after drying for 24 hours at 105°C in the oven. The specimens were then submerged in water for 24 hours before being considered again. Then, we measured the weight of all models submerged. The porosity can be determined from the following equation.

$$\text{Porosity (\%)} = (W_{sat}-W_{dry})/(W_{sat}-W_{sub})$$

Where,
W_{dry}= the average weight of three dry specimens (kg)
W_{sat}= the average weight of three saturated specimens (kg)
W_{sub}= the average weight of three submerged specimens (kg)

2.8.3. Water absorption

A 24-hour immersion test in cold water is done to determine water absorption. A dry block specimen is placed in an oven [Figure 3] between (105 -115) ^{0}C until it reaches a constant mass. After the sample (W_1) was cooled to room temperature, its weight was recorded. The dry specimen was subsequently fully submerged [Figure 4] in water for 24 hours at a temperature of 27.2 °C. The specimen was removed from the water, and a damp cloth was used to remove the surface moisture. The specimen was weighed within three minutes of being removed from the water. Weight (W_2) was the name given to this weight. The relation determines the water absorption percentage by mass following a 24-hour immersion in cold water.

$$\text{Water absorption(\%)} = \frac{W2 - W1}{W1} x100$$

Where,
W_1= Initial weight (kg)
W_2= Final weight (kg)

Figure 3 Blocks are dried in an oven.

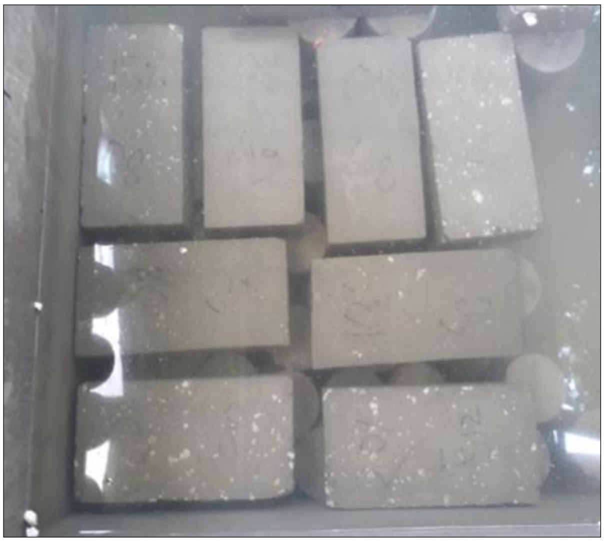

Figure 4 Blocks are immersed in water

2.8.4. Compressive strength

The block was put in a universal testing machine for compressive strength after 28 days of casting. The rate of applying loads was constant. The highest load that was used was noted. The following equation obtained the compressive strength:

Compressive strength = P/ Average Area

Where,
P= Ultimate compressive load for which the block was crushed (kg)
An area of loading surface (m^2)
Here, Loading surface area for block= 10 × 5 = 50 m^2
So, Compressive strength of block = P/50 (kg/m^2)

Figure 5 Compressive strength test of blocks

2.8.5. Heat Passing Rate

After 28 days of casting, the block was placed in all-purpose testing equipment to determine its compressive strength. Loads were applied at a steady rate. It was observed which load was applied at its maximum.

2.8.6. Cost Determination

The cost was calculated based on the building of 100 blocks. For each ratio of 1:4 between cement and sand, the necessary amount of sand, cement, and expanded polystyrene was computed. The price of sand, cement, gravel, and labor was then added to determine the cost of 100 blocks.

i.e., Total cost = Cost of sand+ Cost of cement + Cost of expanded polystyrene+ Labor cost

3. Results and discussion

3.1. Density

The density of Expanded Polystyrene blocks was computed by taking the ratio of the weight of blocks to the volume of the blocks. The dimension of the blocks was known as 10″×5″×3″. The density of expanded polystyrene blocks decreases with increased EPS beads. A comparison of density for various percentages of EPS is given in Figure 6. It is clearly shown that the thickness of blocks for 0% EPS content is the highest amount. The density of EPS blocks gradually decreases with the increase in EPS percentage.

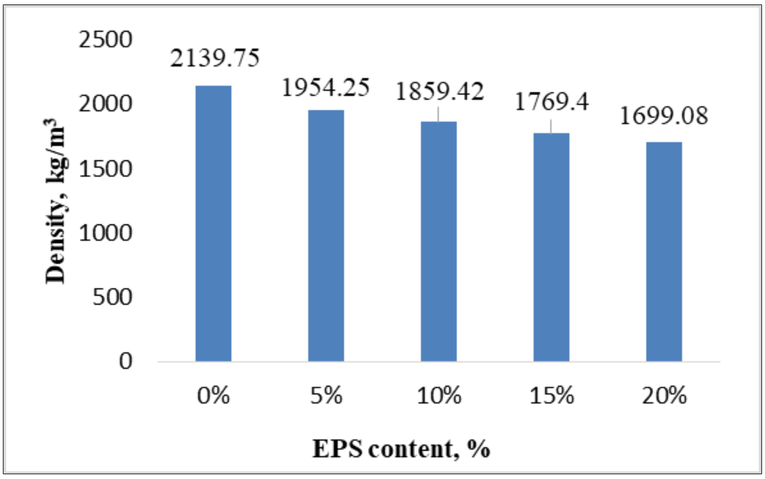

Figure 6 Comparison of density of Expanded Polystyrene blocks at different percentage

3.2. Porosity

The amount of expanded polystyrene added to cement mortar directly correlates with porosity [14]. With an increase in EPS %, porosity rises. Compressive strength and porosity are inversely proportional to one another—the porosity of blocks with various percentages of EPS graphically [Figure 7]. The 20% EPS block exhibits the maximum level of porosity. The compressive strength of the blocks is impacted by porosity. The outcome demonstrates that porosity increases as EPS increases. The block's compressive strength is affected by porosity[15] . The block's compressive strength is low when the block's porosity is large. The outcome demonstrates an inverse connection between compressive strength and porosity.

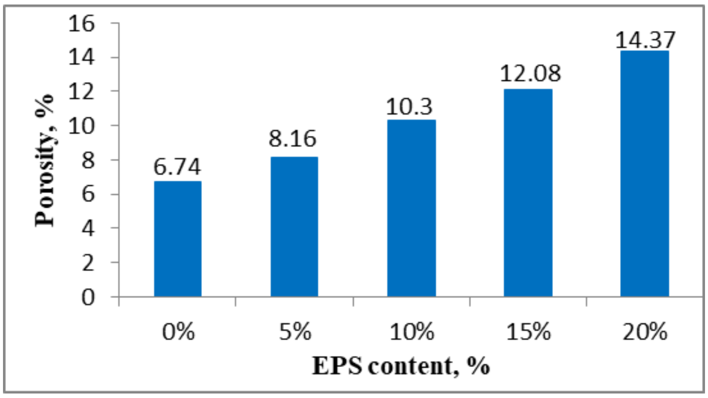

Figure 7 Comparison of porosity of Expanded Polystyrene blocks at different percentage

3.3. Water absorption

Block water absorption rises as EPS % increases. As per ASTM standards, the samples were tested to compare the water absorption of blocks at different EPS percentages [Figure 8]. Blocks' ability to absorb water steadily improves as the EPS percentage rises after 28 days of curing the water absorption rate increases when 20% EPS is mixed into the blocks.

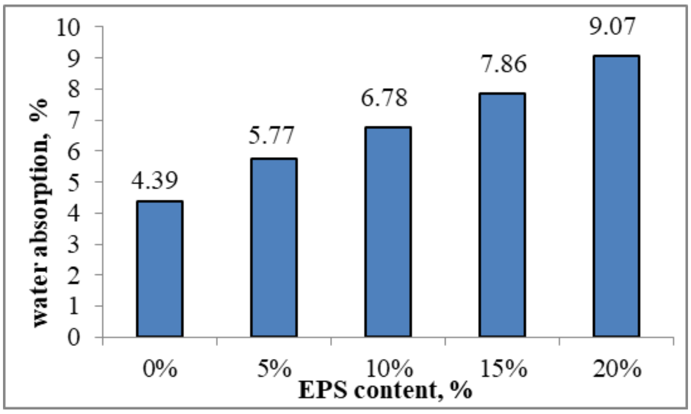

Figure 8 Comparison of water absorption of Expanded Polystyrene blocks at different percentage

3.4. Compressive strength of Expanded Polystyrene blocks (7 days curing)

Testing the compressive strength of a block with various EPS contents over a seven-day curing period is done. It provides a comparison of compressive strength for different EPS percentages. With a 28-day curing age, the compressive strength of prepared blocks gradually declines as EPS % rises. Blocks with 0% EPS concentration have the highest compressive strength [Figure 9].

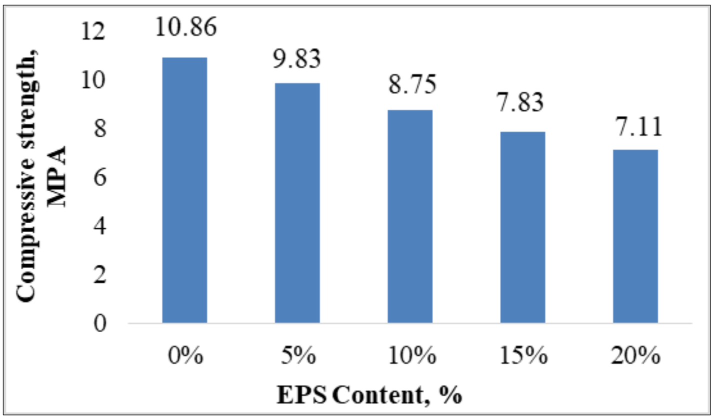

Figure 9 Comparison of compressive strength of Expanded Polystyrene blocks at different percentage

3.5. Compressive strength of Expanded Polystyrene blocks (14 days curing)

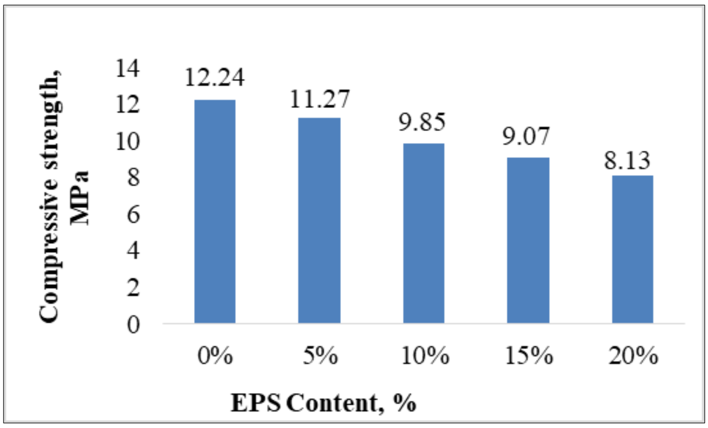

Figure 10 Comparison of compressive strength of Expanded Polystyrene blocks at different percentage

The block's compressive strength is tested with various EPS content levels after a 14-day curing period. Figure 10 provides a comparison of compressive strength for different EPS percentages. The most significant value of all specimens was found at 14 days of 0% curing, where the compressive strength was 1776 psi. It has been found that adding 20% EPS lowers compressive strength.

3.6. Compressive strength of Expanded Polystyrene blocks (28 days curing)

According to this study, the compressive strength of every block of varied curing ages increases as curing time increases. Testing the compressive strength of a block with various EPS contents over a 28-day curing period is done. Figure 11 provides a comparison of compressive strength for different EPS percentages. Up to 28 days, the growth rate in compressive strength with day is noticeably higher. The most significant value among all specimens was the compressive strength, discovered at 28 days of 0% curing. Additionally, Figure 11 demonstrates that adding 20% EPS lowers compressive strength.

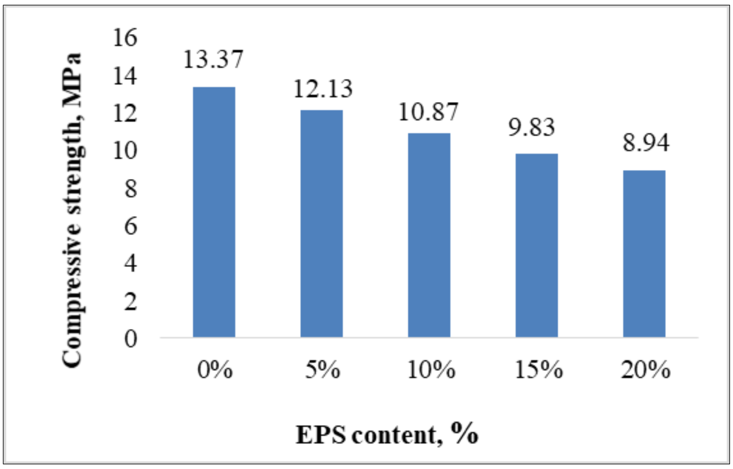

Figure 11 Comparison of compressive strength of Expanded Polystyrene blocks at different percentage

3.7. Compressive strength of Expanded polystyrene blocks at different curing ages

Figure 12 shows the compressive strength after 7, 14, and 28 days of cure. Additionally, it demonstrates the connection between compressive strength and cure times. This figure shows that as the curing duration lengthens, the compressive strength of all blocks with various curing ages increases noticeably. The minimum compressive strength of 7.11 MPa was discovered at seven days of curing, and the maximum compressive strength of 13.37 was found at 28 days. The figure also demonstrates that up to 28 days, or 13.37 MPa, the growth rate in compressive strength every day is noticeably higher.

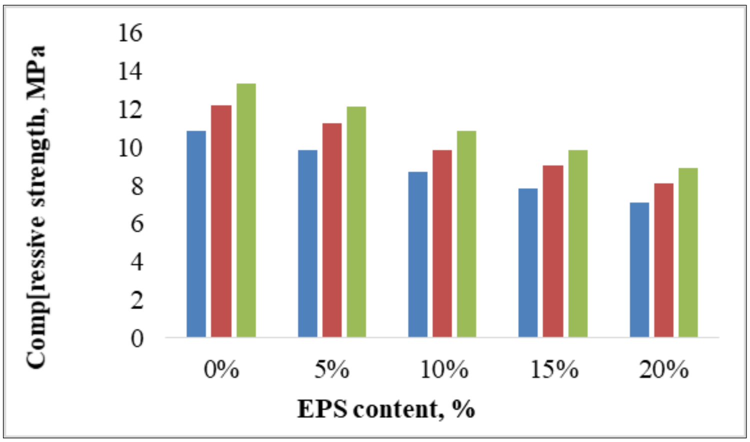

Figure 12 Relationship of compressive strength among different curing age

3.8. Heat Passing Rate

Figure 13 compares the heat transfer rate for varying percentages of expanded polystyrene blocks. Extended polystyrene blocks' ability to conduct heat gradually improves as EPS % rises. When 20% EPS is added, the raised polystyrene block has a high heat transfer rate.

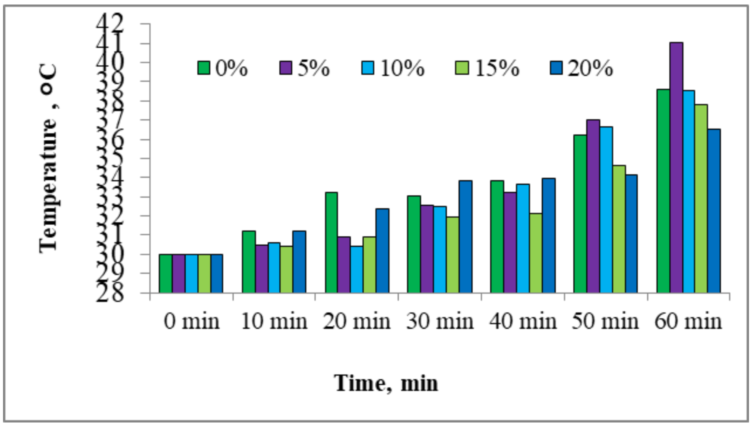

Figure 13 Comparison of Heat Passing rate of Expanded Polystyrene blocks at different percentage

3.9. Particle size distribution curve of sand

The particle size distribution curve of sand describes that the sand is not very fine. It can be used in a non-load-bearing structure [Figure 14]

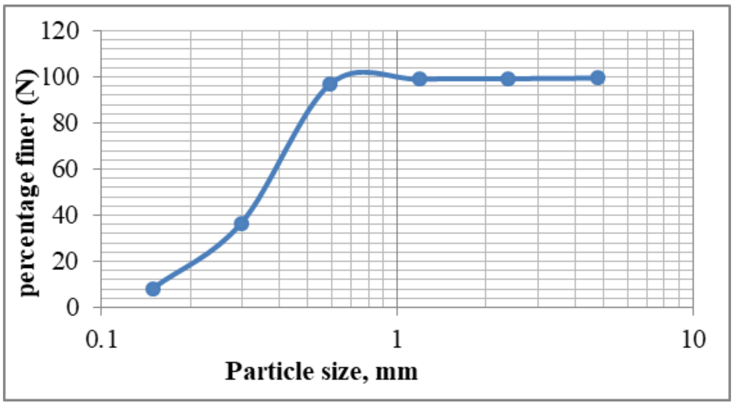

Figure 14 Particle size distribution curve of sand

3.10. Cost of Expanded Polystyrene Blocks

It is observed that the cost of the block increases as the EPS content decreases. A comparison of charge for various percentages of EPS is given in Figure 15. This figure shows that the cost of blocks decreases significantly with the increase in EPS content. The price of prepared blocks for 20% EPS content is the lowest.

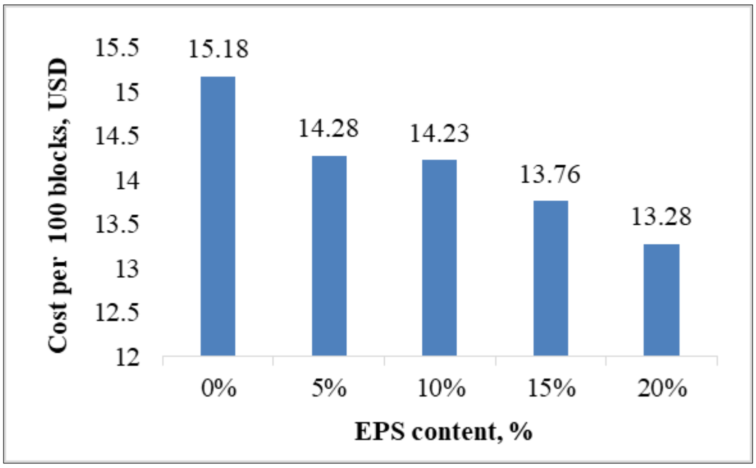

Figure 15 Comparison of cost per 100 blocks at different percentages

4. Discussion of physical test results

The density, porosity, water absorption, compressive strength, heat passing rate, and cost of EPS blocks at each percentage are shown in [Table 1].

Table 1 Combined representation of density, porosity, water absorption, compressive strength, and cost of Expanded Polystyrene blocks (Dimension of the blocks: 10″×5″×3″)

Expanded Polystyrene (%)	Density (kg/m^3)	Water absorption, %	Porosity, (%)	Compressive strength, MPa			Cost, USD/100 blocks	Cost, TK/100 blocks
				7 days	14 days	28 days		
0	2139.75	4.39	6.74	10.86	12.24	13.37	15.18	1641
5	1954.25	5.77	8.16	9.83	11.27	12.13	14.68	1587
10	1859.42	6.78	10.30	8.75	9.85	10.87	14.23	1538
15	1769.40	7.86	12.08	7.83	9.07	9.83	13.76	1487
20	1699.08	9.07	14.37	7.11	8.13	8.94	13.28	1436

Table 1 provides information on the density, water absorption, porosity, compressive strength, and cost of blocks at different percentages of EPS. Here are the key findings from the table:

- **Density:** The density at 0% EPS is the highest, measuring 2139.75 kg/m^3. The lowest density is obtained at 20% EPS, 1699.08 kg/m^3. The density at 15% EPS is similar to the other percentages.
- **Water Absorption:** The highest water absorption is observed at 20% EPS, which is 9.07%. However, all water absorption values are within an acceptable range for building blocks. Good bricks typically do not absorb more than 15-20% of their weight when immersed in water for 24 hours [11].
- **Porosity:** The porosity at 0% EPS, which contains no EPS, is the lowest at 6.74% among all the blocks adding 20% EPS results in the highest porosity at 14.37%. Porosity and compressive strength have an inversely proportional relationship. The porosity at 15% EPS is close to the values of the other percentages.
- **Compressive Strength:** The compressive strength at 0% EPS is the highest, measuring 13.37 MPa. The lowest compressive strength is obtained at 20% EPS, which is 8.94 MPa. The compressive strength at 10% EPS is medium, measuring 10.87 MPa.
- **Cost:** The cost of 100 blocks at 0% EPS is the highest (15.18 USD), while the price of 100 blocks at 20% EPS is the lowest (13.28 USD). There is a correlation between the proportions of cement, sand, and EPS and the cost of the blocks. The higher the EPS percentage, the lower the price. The cost of 20% EPS blocks is the lowest among all other rates.

These findings highlight the trade-offs between different properties and costs when varying the percentage of EPS in the blocks. Density, water absorption, porosity, compressive strength, and cost should be considered when selecting the appropriate EPS content for specific applications.

5. Conclusion

This study has comprehensively assessed Expanded Polystyrene (EPS) blocks with varying percentages. These findings have significant implications for construction material choices, particularly in the context of non-load-bearing walls. The versatility of EPS blocks is apparent, offering a combination of favorable characteristics, including density, porosity, water absorption, and compressive strength. Furthermore, the cost analysis highlights an economical advantage, with the highest percentage of EPS yielding the most cost-effective option. As such, considering these factors, it is reasonable to conclude that EPS blocks present a compelling alternative to conventional hard clay bricks, demonstrating an optimal balance of essential properties crucial for construction materials. It is evident that as the EPS content increases, there is a consistent decrease in block density. This trend is mirrored in the compressive strength, which diminishes gradually with higher EPS percentages. Noteworthy is the observation that water absorption is at its lowest for 0% EPS and peaks at 20% EPS, though all values remain within acceptable limits. Porosity follows a similar pattern, reaching its lowest point at 0% EPS and its highest at 20% EPS. This study expands our understanding of EPS block performance and opens new avenues for sustainable and cost-effective construction practices.

Recommendation

Several key areas warrant further investigation to advance the understanding and application of Expanded Polystyrene (EPS) blocks in construction. Firstly, a comprehensive study examining the strength of EPS blocks over a range of cure times is recommended. Moreover, the current analysis has touched on only a subset of EPS block attributes. Exploring factors such as shrinkage, thermal conductivity, and flexural strength, among others, is imperative for tailoring EPS for specific applications. Additionally, an in-depth examination of concrete strength with varying mixture percentages incorporating EPS blocks is advised. The observed correlation between compressive strength and the fineness modulus (F.M.) of uniform-grade sand presents a valuable insight. Further research into this relationship and its application in concrete work would enhance the efficiency and effectiveness of construction processes. The chemical composition of EPS is a critical factor influencing its properties. Therefore, a deeper exploration of its chemical makeup is essential to comprehensively understand the material's behavior and potential applications. Lastly, the recent decrease in the price of expanded polystyrene blocks has increased sand usage. A more detailed analysis of the cost-effectiveness of different material combinations, considering performance factors, is warranted.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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