PRODUCTION OF LIGHTWEIGHT BUILDING BLOCK

USING EPS BEADS.

By
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A Thesis Submitted to the Department of Civil Engineering in Partial Fulfillment for the degree of Bachelor of Science in Civil Engineering

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Sonargaon University (SU)
147/I, Green Road, Panthapath, Dhaka-1215, Bangladesh
Section:- 15B
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Dedicated

To

"Our Honorable Teachers"

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ABSTRACT

Environment pollution is the most concerned issue in today's world. Construction Industries is one of the largest sectors to pollute the environment. In Bangladesh, burnt clay block is the most commonly used building material which produce a significant amount of greenhouse gasses. For a better environment, alternative sustainable building material is a must. This study appraises alternative building materials and technologies as a walling material. Burnt clay block have been used for long in building construction and its demand is increasing rapidly with the passage of time. In the burning process of clay block air is polluted and necessary clay is collected from agricultural land. As a result, agricultural land is being diminished. So alternative building block can be the possible solution of the disadvantages of burnt clay block. In this thesis, we use four types of blocks. These are Block with EPS beads, Burnt clay block (BCB), Block from Narayanganj (NT), Block from Gabtoli (GT). Among which Block with EPS beads was produced in laboratory. The bulk density of Block with EPS beads, Burnt clay block, block from Narayanganj, block from Gabtoli were 1400, 1741, 1308 and 1500 kg/m3 respectively. The absorption of Block with EPs beads, Burnt clay block, block from Narayanganj, block from Gabtoli were 9.6, 13.1, 11.9 and 10.5% and respectively. The 28 days compressive strength of these blocks were 1740, 3300, 2040 and 1800 psi respectively. So for use in construction block from EPS beads is better than other types.

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Chapter 1
INTRODUCTION

General

Burnt clay block have been used for long in building construction and its demand is increasing rapidly with the passage of time. In the burning process of clay brick air is polluted and necessary clay is collected from agricultural land. As a result, agricultural land is being diminished. Using alternative light weight block in building construction foundation cost can be reduced as foundation treatment is directly related to the load of the structures. At present, energy use has become a burning question word wide, in which building consume between 20 and 40% of the total energy consumption in developed countries (Camila Barreneneche, 2013). Energy consumption can be reduced using alternative building blocks. Bangladesh is a tropical country. The maximum temperature of summer lies between 350C to 430C and in winter temperature lies between 150C to 250C. The tropical region is an uncomfortable climate zone that receives a large amount of solar radiation, high temperature, high level of relative humidity, and long periods of sunny days throughout the year (Oğulata, 2002). In various countries, energy consumption of building causes around 40% of global energy demands. For space heating and cooling of a building the requirement of energy is almost 60% of the buildings total energy consumption which causes maximum percentage of energy usage. Typical high temperatures in tropics can range from 30 °C (85 °F) in the winter to 35 °C (95 °F) in mid-summer. In the case of tropical islands like Puerto Rico, humidity and other factors contribute to a heat index factor" which is generally 5- 10 degrees higher than the actual temperature (Jorge L. Alvarado E. M., 2008). Typical concrete houses located in tropical places without proper ventilation can experience high temperatures which are usually greater than the outside dry bulb temperature (Jorge L. Alvarado E. M., 2008). Unwanted thermal energy accumulates in buildings and dwellings from a variety of sources, such as heat from interior appliances, equipment, and occupants; solar radiation; and radiation- or convection induced heat transfer and air infiltration through walls. Undesirable thermal energy storage is a critical issue in the tropics where cement-based materials (i.e. concrete) are routinely used in the construction of buildings. Concrete and other cement-based material can absorb thermal energy for long periods of time especially when they are subjected to high ambient temperatures, which fluctuate between 310 C (88 F) in the winter and 340C (93 F) in the summer in tropics (Jorge L. Alvarado W. T., 2009). Critical challenge in the society is the climate change and need massive energy savings in construction. Selection of proper building materials which are able to function as thermal barrier in order to prevent heat has to be done to minimize the usage of energy and enhance the comfort zone of indoor environment (Shankar Ganesan, 2015).

There are plenty of cheap and common insulation materials available on the market today. Each of these insulation materials have their own ups and downs. Considering differences like price, environmental impact, flammability, sound insulation and other factors, there are some common types of insulation materials such as Fiberglass, Mineral Wool, cellulose, Polyurethane Foam, Polystyrene (EPS). Expanded polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are made of 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. It has a good thermal insulation characteristics as well as impact resistance (Thomas Tamut, 2014). In Bangladesh a study in the field of these construction materials has been initiated in Housing and Building Research Institute. In Dhaka, a series of experiments were carried out on the manufacturing and properties of alternative building block in own context. To satisfy green building requirements and supporting sustainable development, the block produced from EPS beads may be use in Bangladesh. In this research, an attempt was taken to produce lightweight building block using Expanded Polystyrene EPS beads and its thermal insulation property was investigated through experimentation for reducing indoor room temperature.

Objective of Study:

The objectives of this study are as follows:

i. To produce lightweight building block.
ii. To investigate the physical and mechanical properties of the block.
iii. To reduce environment pollution and encourage people to use alternate block.

1.1.1 Brick kilns top polluter in Bangladesh:

Brick kilns are the top air polluter in seven major cities in the country, particularly during dry season when most bricks are made, turning the air quality of these metropolises “Severely unhealthy”.

Also to blame are construction work that kicks u dust, poorly-maintained vehicles that emit excessive harmful particles and toxic gases, and industrial air pollution, according to the department of Environment (DOE).

A five-year survey by the department found Narayanganj has the most polluted air, followed by Dhaka. Third is Gazipur, which is followed by Rajshahi, Chattogram, Khoulna, and Barisal.

Figure1.1. Brick kilns top polluter in Bangladesh

1.1.2 Agricultural land is cut by cutting soil and brick kiln:

The soil of the crop land is being cut and taken to the kiln. The soil is losing its fertility as the upper part of the land i.e. the top soil brick goes down. As a result, hundreds of acres of land have become uncultivated and there is a danger of food shortage. In the aman season, as soon as the paddy is harvested, the process of cutting the soil from the of cutting the soil from the crop land and taking it to the brick kiln begins. The owner off the brick kiln and some unscrupulous soil traders are showing greed for money to the farmers by cutting the soil with the help of workers or machines.

Figure1.2: Agricultural land is cut by cutting soil and brick kiln

Block with EPS Beads:

We make block by EPS beads with cement and sand mixing materials and casting block in laboratory. It makes ratio 5% EPS Beads and 95% cement and sands.

APPLICATION OF ALTERNATIVE BUILDING MATERIAL:

The customary building construction trend in Bangladesh usually focuses on the use of burnt clay bricks for the infill and Reinforced Cement Concrete frame structures. Under the study project the researcher try to establish CSEB, Hollow Block, Thermal Block and others material as an infill wall material.

Figure 1.3: Model House-II using Compressed Stabilized Earth Block and Thermal Block at HBRI campus

Use of Interlocking, Compressed Stabilized Earth Block (CSEB)

To find out the performance of interlocking block, HBRI has taken initiatives to complete a one storied building within an area of about 320sft. The successful implication of interlocking bricks can be proved to be an exceptional substitute to burnt clay bricks.

Figure 1.4 Model house-I with interlocking blocks

Significance of Research:

Providing new knowledge to the contractors and developers about alternative lightweight building blocks produced by EPS beads with mortar. The used EPS beads are lightweight and having good thermal insulation property. At present, Bangladesh government is encouraging to use alternative building blocks instead of burnt claybricks in all government project. These blocks may be the solution in this condition. In the construction process of these blocks no

smoke is produced and huge amount of energy can besaved required for cooling purposes. To satisfy green building requirements and promoting sustainable development, these blocks may be use in Bangladesh.

Organization of Thesis:

The layout of the thesis is written through five chapters in the following sequence. **Chapter One** deals with the importance, objectives and significances of the research in a comprehensive style. The first chapter is the introduction to our work. **Chapter Two** is literature review which includes the definition of thermal insulation, advantages of thermal insulation, some common materials used for thermal insulation, Previous studies on alternate building block having thermal insulation property. **Chapter Three** contains Methodology and Experimental Prograom, Mix Design, Density EPS beads, Manual mixing. **Chapter Four** contains the experimental results along with the data, figure and graphs obtained from the laboratory tests and discussions on the test results**. Chapter Five** describes conclusion of the research work and recommendation for further research.

`

Chapter 2

LITERATURE REVIEW

General

Alternative building block is necessary because traditional burnt clay brick having much weight produce smoke in construction process which pollutes the environment and necessary clay is collected from agricultural top soil. This practice is diminishing the agricultural land. The lightweight building blocks produced by EPS beads can be used as alternative building material in Bangladesh. These blocks are lighter and having good thermal insulation property as EPS is a good heat insulator. Heat Insulation is very important factor for the comfort of people living in residential building. Wall made from these blocks can reduce room temperature. As a whole, these blocks are economical, less energy intensive, fire resistant, environment-friendly and recommended for earthquake resilient buildings.

`

Sand Cement Hollow Block

A Sand Cement block is one of several precast concrete products used in construction. Hollow block helps in saving construction materials and therefore use of hollow block reduces construction cost. Use of larger size concrete block reduces number of joints in work and hence helps in saving mortar. Sand Cement Hollow block masonry can safely withstand the atmospheric action and it requires no protective covering. Hollow block have good insulating properties against sound, ==heat and dampness. Presence of rough surface on blocks provides good bonding of mortar and plaster.

Figure 2.1. Hollow Concrete Block (Md. Akhter Hossain Sarker, 2018)

Autoclaved Aerated Concrete

Autoclaved Aerated Concrete is a lightweight, precast, foam concrete building material suitable for producing concrete masonry unit (CMU) like blocks. Composed of quartz sand, calcined gypsum, lime, cement, water and aluminum powder, AAC products are cured under heat and pressure in an autoclave.

`

Figure 2.2 Autoclaved Aerated Concrete Block (Md. Akhter Hossain Sarker, 2018)

Compressed Stabilized Earth Block (CSEB)

Housing and Building Research Institute has produced CSEB from the dredged soil of river mixing with proportionate cement. The production cost of CSEB is near about half of the conventional burnt brick.

Figure 2.3 Compressed Stabilized Earth Block (CSEB) (Md. Akhter Hossain Sarker, 2018)

Interlocking CSEB

These types of blocks are prepared with proportionate mixing of dredged soil from river with cement and sand. It is possible to prepare wall without any mortar due to its' interlocking mechanism.

`

Figure 2.4 Interlocking Compressed Stabilized Earth Block (Md. Akhter Hossain Sarker, 2018)

Thermal Block

Thermal Block is produced using EPS Sheet with both side mortar. The advantage of thermal Block is that it has good thermal and sound insulation properties. Moreover, the weight of the block is almost half of the traditional or fire brick

Figure 2.5 Thermal Block (Md. Akhter Hossain Sarker, 2018)

Study on Heat Insulation System and EPS

Thermal insulation is an important contributor and very practical and logical first step towards obtaining energy efficiency. Nowadays it is a major concern to reduce the difference of indoor and outdoor room temperature.

Vadim Nikitin and Andrzej Lapko used capillary porous material in real wall and slab

`

structures which was exposed to ambient air. Heat transfer in multilayer sandwich panel was studied. foamed polyurethane was used in concrete. It was found that the improvement of computational accuracy of modelling of the thermal engineering problems requires an accurate real parameters which characterize capillary-porous structural materials (Vadim Nikitin, 2006). Sofia Knapic et. al. (2016) produced Prototype boards of high-density expanded cork agglomerates (230 and 290 kg/m^3). Tensile strength, hardness, thermal conductivity, and reaction to fire was observed. It is good for heat insulation (Knapic, Santos, Pereira, & Machado, 2017).

Bjørn Petter Jelle concluded that nowadays there exist no single thermal insulation material which can satisfy thermal conductivity, perforation vulnerability, building site adaptability, mechanical strength, fire protection, fume emission during fire, robustness, climate ageing durability resistance towards freezing/thawing cycles, water resistance, costs and environmental impact. New design should be made to reduce heat insulation (Jelle, 2011).
J.J. del Coz Díaz et. al. (2007) used finite element method and found that 0.30* 0.30* 0.20 m and 0.30* 0.25* 0.20 m (long*width*height) hollow bricks are good for thermal insulation with a minimum weight and to obtain thermal insulation with minimum thickness of wall 0.50* 0.25* 0.20 m and 0.50* 0.20* 0.20 m hollow bricks should be used (J.J. del Coz Díaz, 2007). Thomas Tamut et. al. (2014) used EPS beads in concrete and found that compressive strength of 5%, 10%, 15%, 20%, 25% and 30% EPS incorporated concrete strengths were 91%, 77 %, 71%, 63%, 57%, and 45%, respectively when compared to concrete with no EPS case (Thomas Tamut, 2014).

Dr. Mohammad S. Al-Homoud used various type of heat insulating material and conducted research and found that Fiberglass (open cell structure) Expanded Polystyrene (closed cell foam) Extruded Polystyrene (closed cell foam) have Thermal conductivity 0.035–0.032,0.038–0.037,0.032–0.030 (W/m-K), which are good heat insulator (Al-Homoud, 2005).

Bing Chen and Juanyu Liu used styrene-butadiene rubber (SBR) latex as a polymeric admixture in lightweight expanded polystyrene (EPS) concrete, in this case SBR increased flexural strength. Unmodified EPS concretes without SBR show the highest flexural strength and concluded that the strength development of the polymer-modified EPS concretes strongly depends on the curing conditions (BingChen, 2007).

`

EPS is a type of insulation that is molded or expanded to produce coarse closed cells containing air. Expansion is achieved by virtue of small amount of pentene gas dissolved into the polystyrene base material during production. EPS foam products whether used for insulation or packaging are lightweight, versatile, sanitary, energy efficient, and most importantly cost effective.

Expanded polystyrene beads (EPS) is one of the industrial solid waste that having serious

problem for disposal. The world today has concern in environmental issue, the problem to accumulate of unmanaged solid waste. The EPS is not a biodegradable type; it will not provide an environmental friendly solution to landfills. In increase concern for environmental issues, the sustainable development and energy conservation concept has become paramount importance. It is one of many lightweight, low strength materials with density between (16-27) kg/m^3 and good energy absorbing characteristics. It is well known for its good thermal and acoustic insulation properties leading mainly to non-structural applications including precast roof and wall panels and lightweight infill blocks. It also in the way to reduce the density of the bricks, as well in improving thermal insulation properties, there forms the light weight brick innovation.

`

Chapter 3

METHODOLOGY AND EXPERIMENTAL PROGRAM

3.1 MATERIALS

Cement: Ordinary Portland Cement (Type I) was used which is locally available and its specific gravity is 3.15.

Sand: Sylhet sand was used for producing lightweight building block and local sand was used for capping building block specimen for performing compressive strength test.

EPS beads: Expanded polystyrene (EPS) beads was used with cement sand mixture to reduce the amount of cement and sand in mortar and dead weight of the block

(a) Cement

(c) Local Sand

(d) Sylhet Sand

(f) EPS Beads

Figure 3.1 Materials used in this Project

`

3.2 DETERMINATION OF MATERIAL PROPERTIES

3.2.1 Unit Weight:

The unit weight is the weight per unit volume of a material. The symbol of unit weight is γ. A commonly used value is the unit weight of water on Earth at 4°C, which is 9.807 kN/m³ or 62.43 lbf/ft³. The terms specific gravity, and less often specific weight, are also used for relative density Determination of the unit weight of coarse and fine aggregates in a compacted condition. ASTM Test Method C 29 represents unit weight in a compacted or loose condition and calculation of voids in fine, or coarse aggregates. It is essential for selecting proportions for concrete mixtures.

3.2.2 Fineness Modulus:

The Fineness modulus is an empirical figure obtained by adding the total percentage of the sample of an aggregate retained on each of a specified series of sieves, and dividing the sum by 100. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates (ASTM C 125, C 136) was used to determine fineness modulus of fine aggregates.

3.3 Determination of Density

Density is a measurement that compares the amount of matter an object has to its volume. An object with much matter in a certain volume has high density. An object with little matter in the same amount of volume has a low density. Density is found by dividing the mass of an object by its volume. The process of mixing concrete can be modified to form a higher or lower density of concrete end product. After remolding the cylindrical mold, the mass, diameter and height of the specimen was taken. It was done before starting of curing process. Finally, the density was calculated by dividing the mass by the volume of the specimen. In figure 3.2 shows the measurement of density of EPS beads.

`

Figure 3.2 Density measurement of EPS beads

3.4 PREPARATION OF MIX DESIGN

3.4.1 Mix Design for Building Blocks

An appropriate mix design ratio was Calculated to prepare the mortar required to produce light weight building block according to the ACI standards.

Table 3. 1: Mix Proportions for Two Types of Building Blocks

Types of block	Cement (Kg/m3)	Sand (Kg/m3)	EPS Beads(Kg/m3)	Water(Kg/m3)
Block with EPS Beads, Cement : Sand : EPS Beads=1:3: 0.76	287	924	3.832	180

`

3.4.2 Mixing procedures

For relatively less amount of mortar required manual hand mix procedure was used for mixing Concrete. All the constituent materials were collected and weighed properly. The weighted materials were taken in a pan and mixing process was completed. The manual mixing processis shown in Figure 3.3.

Figure 3.3 Manual mixing

3.5 PREPARATION OF THE SPECIMENS

3.5.1 Casting of Block of EPS Beads Types of Building Block

For performing compressive strength, density, water absorption and thermal insulation test two types of building block were produced. The size of the block was 9.5” X 4.5” X 2.75” which is same as burnt clay brick. The number each Type of block casted was 9. The total number of block produced was 18. The schematic diagram of building block is shown in figure 3.4. The small rectangle in the centre of the block indicates the size of the EPS beads.

For making block lightweight and thermally insulated used in one type and EPS Beads was used in another type of block. All the specimens are shown infigure 3.5.

Mold

Casting

Block

Figure 3.4 Block with EPs Beads

Collected Types of Bricks:

Burnt Clay block (BCB) :

Figure 3.5 : Burnt Clay block

Narayanganj block (NT) :

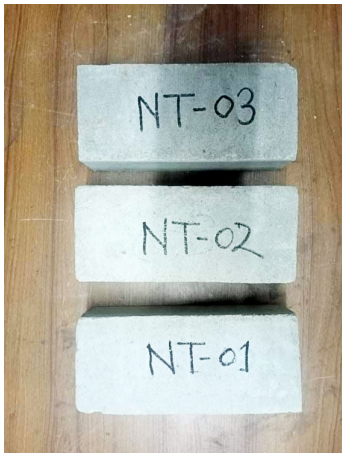

Figure 3.6: Narayanganj block

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Gabtoli Block (GT):

Figure: 3.7: Gabtoli Block (GT):

Determination of Compressive Strength

Compressive strength test of bricks are performed according to ASTM C67-03 to determine the load carrying capacity of bricks under compression with the help of compression testing machine. This is one of the most important and significant properties of building block. In this report the compressive strength of different types of building block including burnt clay brick were determined at the age of 7, 14 and 28 days. The typical setup for compressive strength of building block is shown in the Figure3.2.

`

Figure 3.8: Typical setup for compressive strength determination

The compressive strength was determined by using equation

(1) C=P/A

Where,

C = Compressive strength

P = Failure load
A = Contact area.

`

Determination of Water Absorption

Water absorption test on bricks are conducted according to ASTM C-67-80 to determine durability property of bricks such as degree of burning, quality and behavior of bricks in weathering. A brick having water absorption of less than 7% provides better resistance to damage by freezing. The water absorption by bricks increase with increase in pores. So, the bricks, which have water absorption less than 3percent can be called as vitrified. This test provides the percentage of water absorption of bricks and procedure of the same is discussed below. Dry the specimen in a ventilated oven a temperature of 105°C to115°C till it attains substantially constant mass. Immerse completely dried specimen in clean water for 24 hours.

Figure 3.9 : Water Absorption

Determination of Density of building block

Density is a measurement that compares the amount of matter an object has to its volume. An object with much matter in a certain volume has high density. An object with little matter in the same amount of volume has a low density. Density is found by dividing the mass of an object by its volume. We have collected data of length, width and height of the block. Then we determine density of the block by dividing block weight by the volume of the blocks.

Chapter 4

RESULTS AND DISCUSSIONS

In this chapter, the result obtained from the experimental investigations are reported using necessary graphs, histograms and tables. All the values reported are the average of the three trials in each case in this study.

4.1 Bulk Density

The bulk density of 4 types of block were determined. Among these, 2 types of block were prepared. Other two types of block were burnt clay brick and commercial solid block made of cement, sand and crushed stone. These densities are shown in figure 4.1. It was observed that the density of block with NT and EPS beads is less than other types which indicates that the block made of EPS Beads is lighter than other types of block.

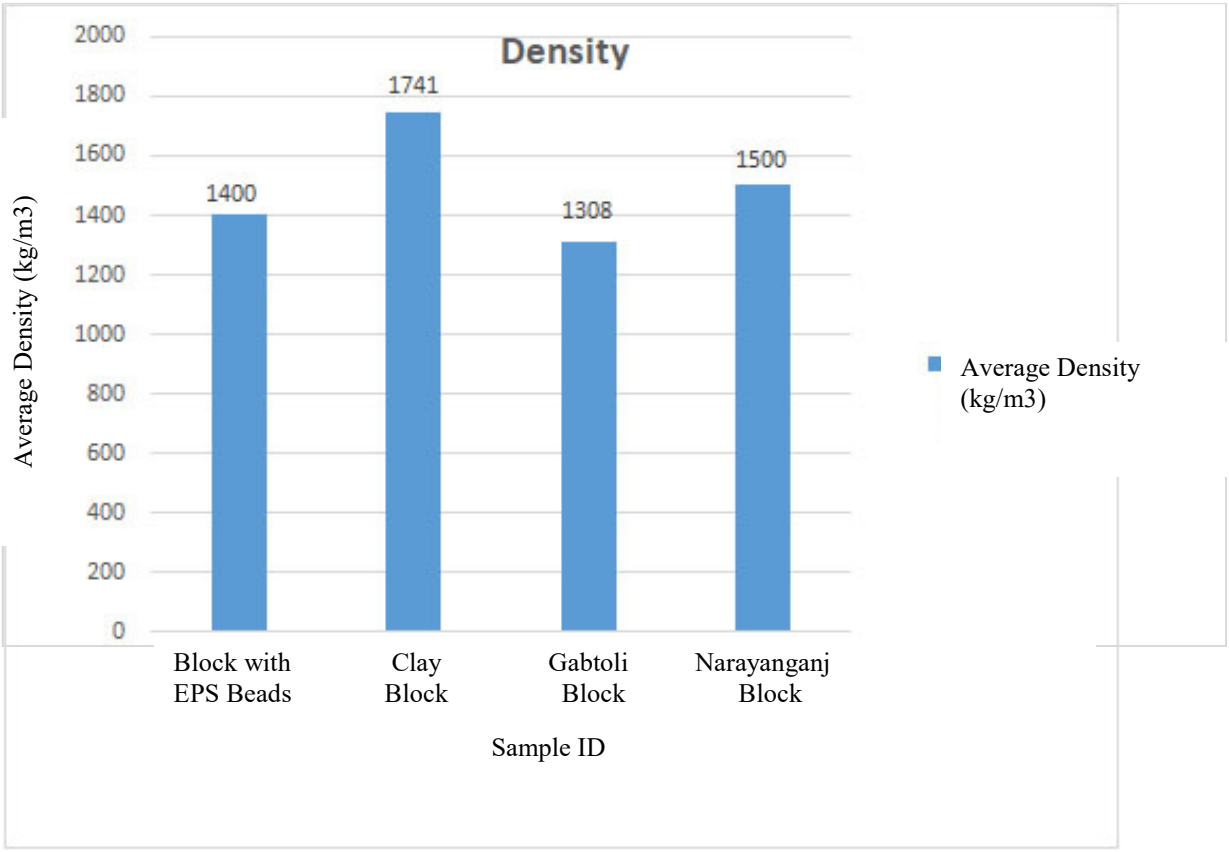

Figure 4.1 Comparison of Density of Different Types of Building

4.2 Absorption of Different Types of Building Block

Water absorption test on bricks is conducted to determine the compactness of bricks as water is absorbed by pores of the bricks. The water absorption increase in bricks with the increase of pores. This test is done to measure the physical property of bricks. A brick having water absorption of less than 7% provides better resistance to damage by freezing. The water absorption of 4 types of building block are shown in figure 4.2. The water absorption of block NT with EPS beads are 10.5 and 9.6% respectively. These values are less than the absorption of clay brick. These values are very close to the absorption of commercial solid block.

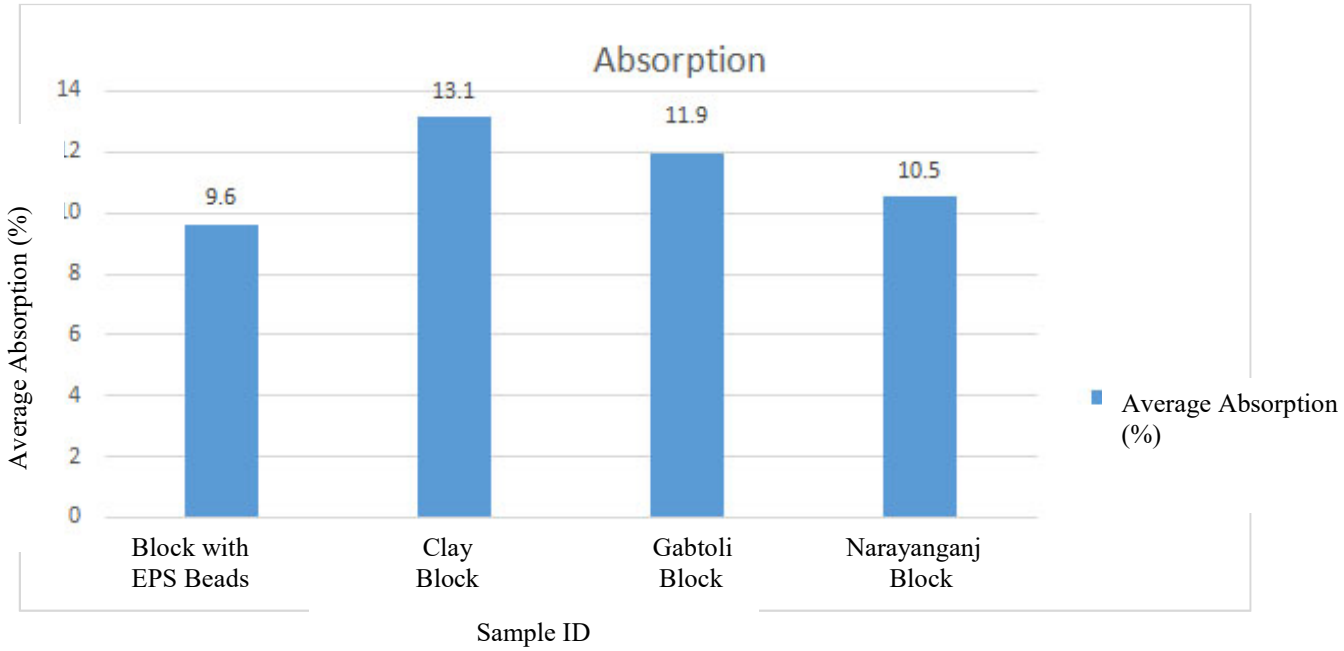

Figure 4.2 Absorption of Different Types of Building Block

4.3 Compressive Strength of Building Block

Compressive strength of block was determined for 28 days of curing. In a previous study, comparison of compressive strength reveals that concrete with 82.22% EPS volume reached a strength of 0.08 MPa after 28 days, while the strength of 0.067, 0.24, 0.29 and 0.85 MPa was obtained for specimens containing 73.10, 67.40 and 45.0% polystyrene beads, respectively (Ali A. Sayadi, 2016). This test was conducted for 4 types of blocks. Among these, 2 types of block were prepared. Other two types of block were burnt clay brick and commercial

solid block made of cement, sand and crushed stone. There compressive strength is shown in figure 5.3.

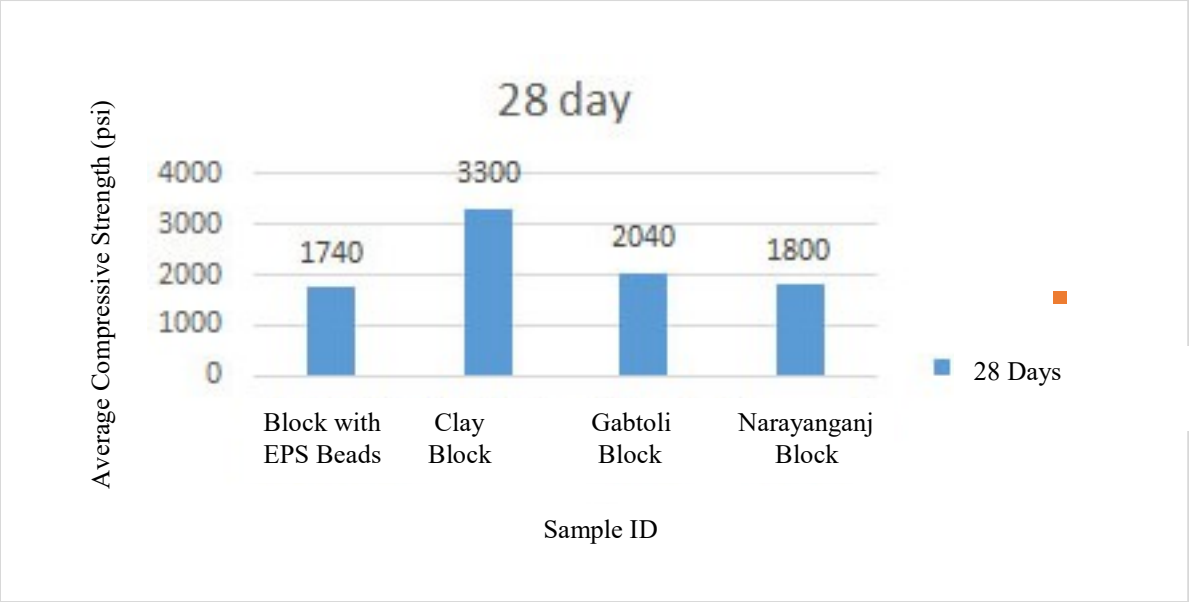

Figure 4. 3 Comparison of Compressive strength of Different Types of Building Block

In this study, the 28 days compressive strength found for the block with NT block NT with EPS beads are 1800 and 1740 psi respectively. These are less than the compressive strength of clay brick. The compressive strength of commercial solid block foundwas 2040 psi which is less than the compressive strength of block with EPS beads. The minimum compressive strength of brick is 1500 psi. It is observed that, compressive strength of block with EPS beads satisfy the minimum compressive strength criteria.

Chapter 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The main objective of this project is to study the effectiveness of lightweight building block made of EPS beads. In this study, It was observed that the density of blockwith EPS beads is less than other types which indicates that the block madeof EPS Beads is lighter than other types of block. It was observed that the compressive strength of block with EPS beads is slightly less than other type of block but the density of this type of block is lower than other type of blocks whichproves it lighter. The water absorption of block with EPS beads and block with NT and EPS beads are 10.5 and 9.6% respectively. These values are less than the absorption of clay brick. These values are very close to the absorption of commercial solid block. In this study, the 28 days compressive strength found for the block with NT and block with NT and EPS beads are 1800 and 1740 psi respectively. These are less than the compressive strength of clay brick. The compressive strength of commercial solid block found was 2040 psi which is less than the compressive strength of block with EPS beads. The minimum compressive strength of brick is 1500 psi. It is observed that, compressive strength of block with EPS beads satisfy the minimum compressive strength criteria. The RCPT test result found for the block with NT and EPS beads, block with NT and EPS beads and commercial solid block were 3582, 3163 and 4321 coulombs respectively.

5.2 Recommendations:

The following recommendation may be proposed for further study:

5.2.1 Number of sample for each test should be increased.

5.2.2 Different percentages of EPS beads can be used.

5.2.3 Before using this types of blocks commercially in building construction more extensive research is need to be done.

5.2.4 For satisfying strength requirement, strength improving admixtures can be used forfurther research.

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APPENDIX

Table 1: Density of Different Types of Building Blocks

Types of BlocK	Serial No	Sample ID	Density (Kg/m3)	Average Density (Kg/m3)
Block with EPS Beads	1	AB-1	1400.00	1400
	2	AB-2	1420.00	
	3	AB-3	1380.00	
Burnt Clay Brick	1	BCB -1	1740.00	1741
	2	BCB -2	1742.00	
	3	BCB -3	1741.00	
Block From Narayangonj	1	NT-1	1305.00	1308
	2	NT-2	1310.00	
	3	NT-3	1309.00	
Block From Gabtoli	1	GT-1	1500.00	1500
	2	GT-2	1520.00	
	3	GT-3	1480.00	

Table 2: Absorption of Different Types of Building Blocks

Types of BlocK	Serial No	Sample ID	Absorption (%)	Average Absorption (%)
Block with EPS Beads	1	AB-1	9.6	9.6
	2	AB-2	9.2	
	3	AB-3	9.8	
Burnt Clay Brick	1	BCB -1	13.0	13.1
	2	BCB -2	13.2	
	3	BCB -3	13.1	
Block From Gabtoli	1	GT-1	10.0	10.5
	2	GT-2	10.8	
	3	GT-3	10.7	
Block From Narayangonj	1	NT-1	11.5	11.9
	2	NT-2	12.2	
	3	NT-3	12.0	

Table 3: Compressive Strength of Different Types of Building Blocks

Types of BlocK	Serial No	Sample ID	Compressive Strength (psi)	Avg. Compressive Strength (psi)
Block with EPS Beads	1	AB-1	1760	1740
	2	AB-2	1720	
	3	AB-3	1740	
Burnt Clay Brick	1	BCB -1	3200	3300
	2	BCB -2	3400	
	3	BCB -3	3300	
Block From Gabtoli	1	GT-1	2040	2040
	2	GT-2	2000	
	3	GT-3	2080	
Block From Nayangonj	1	NT-1	1800	1800
	2	NT-2	1780	
	3	NT-3	1820	