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Experimental Study on properties of Lightweight Sandwich Concrete Blocks using EPS Sheet

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Abstract - *In civil engineering, due to urbanization the demand for construction material increases, hence leading to prominent effect on economic system of nation. In construction field, concrete is most important ingredient. This increases quest for use of sustainable and ecofriendly materials in construction industry. In thus project work, using Expanded Polystyrene (EPS). It is a non-biodegradable waste material which is coming from packaging industry. Substituting partially sand and coarse aggregate by inserting EPS Sheet, to achieve decent compressive strength and water absorption result. This project focus on investigating the characteristics of M25 grade concrete. The modern EPS Sandwich Concrete Block is a new invention or researched type of block, in which Expanded Polystyrene (Thermocole) material is used. And it gives an additional property to the block. Hence these blocks are useful in various climatic conditions. When this Thermocole Sandwich Concrete Block is used in construction work, they reduce the construction time as well as construction cost. Also, there is no necessity of finishing. Eighteen blocks of size 190mmX90mmX55mm were prepared using combination of cement, sand, aggregate and EPS, without using any bonding material. The paper highlights the study properties such as compressive strength and water absorption of EPS based concrete blocks which is compared with conventional concrete*

Key Words: **Expanded Polystyrene (EPS), compressive strength, water absorption, Sandwich Concrete Block, Thermocole, Sand, Aggregates.**

1. INTRODUCTION

The initial basic needs of human being are food, water, clothing and shelter. In this 21st century housing demand has risen due to rapid population growth and consequent rural to urban migration. As the demand is increases for housing, therefore there is huge rise in demand for conventional building material. Therefore, this has resulted in shortage of conventional building material. The human being demand for strong, durable and economical house at minimum time requirement and at affordable cost, but it is difficult by using traditional construction material and methods. Due to industrialization construction industry is growing day by day along with this there is increase in demand of construction materials. For sustainable development there is need of utilizing alternative materials in construction and utilization of waste material is very important aspect of sustainability.

Lightweight pre-fabricated sandwich structural elements in building construction is a growing trend in construction all over the world due to its high strength-to weight ratio, reduced weight and good thermal insulation characteristics. Sandwich construction element consists of encasement of high-performance material and a thick lightweight and low strength material as core. Sandwich composite structure possesses excellent flexural and shear properties. Their inherent lightweight characteristics make them ideal structural components where weight reduction is desirable. Thus, structural sandwich blocks are becoming important elements in modern lightweight construction. In concrete construction, self-weight of structure it represents a very large proportion of the total load on the structures thus, reduction in the self-weight of the structures by adopting an appropriate approach results in the reduction of element cross-section, size of foundation and supporting elements there by reduced overall cost of the project. The lightweight structural elements can be applied for construction of the buildings on soils with lower load bearing capacity. Reduced self-weight of the structures

using lightweight concrete reduces the risk of earthquake damages to the structures because the earth quake forces that will influence the civil engineering structures and buildings are proportional to the mass of the structures and building.

Polystyrene is one of the highly popular plastic packaging materials. It is waste material induced from packaging industry which causes pollution and is harmful to ecosystem. This waste is becoming expensive to dispose. Due large and bulky nature, polystyrene take up significant space for its disposal and also its treatment and disposal are creating environmental sustainability problem. Currently millions of tons of waste polystyrene are produced in world. Polystyrene Foam is a non- biodegradable material. Polystyrene is essentially non-biodegradable and taking thousands of years to decompose in case of land filling. Other disposal methods or treatments methods are creating hazardous effect on environment. However, this material is having properties such as sound insulation, high thermal conductivity, and lightweight so we can use these materials in construction industry which will add new material for construction and add new method of its disposal which is environmentally friendly.

Expanded Polystyrene technology construction offers a better solution for this 21st century or modern construction. EPS is lightweight, rigid plastic insulation, minimum water absorption quantity and good insulation property. The EPS panels are made in factory and they are taken directly on the site for assembling and then taken for plastering or shotcreting. Also, the EPS panels made on site, making assemble and then plastering or shotcreting is done.

2. LITERATURE REVIEW

1. **Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade, Sangram Naik, AmrutaKulkarni(2015):** following conclusions were drawn from this study. 1) Hereby, they have observed that cost of EPS is less compared to that of normal concrete. 2) Increase in the EPS beads content in concrete mixes reduces the compressive and tensile strength of concrete. 3) All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished. 4) The replacement by using EPS has shown a positive application as an alternate material in building nonstructural members, and it also serves as a solution for EPS disposal. 5) Obtained results suggest that expanded polystyrene concrete has scope for nonstructural applications, like wall panels, partition walls, etc.[1]
2. **S. Ananda Selvan and P. Asha (2016):** have an experimental study on the lightweight polystyrene sandwich blocks for replacement of bricks. An experimental study was conducted to investigate the compressive strength of lightweight sandwich blocks since the weight of common building bricks is more or less weight concrete blocks. Specimen block of size 400x200x100 mm were prepared using combination of cement, sand, wire mesh and thermocole with and without different shear connector. In order to make use of this building material more efficiently and make people aware of its benefits, an organized technique is required to promote them. The test result are compared with each other and found that the light weight polystyrene sandwich concrete block offered higher compressive strength of 1.12Mpa at 28 days. The density is found 1200Kg/m^3. Hence there is a reduction of dead load, faster building rates in construction and lower haulage and handling cost.[2]
3. **Pradeepa S., Anitha J., Tamil Selvi(2016):** has study on use of reinforced thermocole panels as an alternate building material. Thermocole or polystyrene has already found extensive use as filler material in structural members. Various studies have also shown that thermocole panels offer high bending stiffness at low densities due to minimal compressive and flexural strength. To determine the suitability of using reinforced thermocole

technology in construction. Hence technology offers a way of meeting the housing demand at a total lower cost. Thus we aim to prove that by using reinforced thermocole as an alternate building material we can achieve an easy ,fast and cheap method of construction.[3]

4. **Piyush Bhandari(2016):** There is huge growing requirement of building material in India due to the existing housing shortage of 46.3 million units mainly for the low income group in urban India. Thus total estimated housing shortage for urban and rural India in 2015 was 128.43million units. To fulfill this basic need of urban habitat, India requires innovative, energy efficient building materials for strong and durable housing in fast track method of construction at affordable cost. lightweight prefabricated sandwich wall panel which provide rapid or faster construction and contributes to environmental protection , can provide a solution to many of the above issues and concerns. The study conducted involved the development of high performance cement based mortar mix to cast ferrocement cover. The results revealed the potential application of ferrocement cover over lightweight insulation core to produce lightweight structure which leads towards the industrialization of building system.[4]
5. **Elamurugu.P, Vijaya Sarathy.R (2016)** : The researches made by different experts, show that, partial replacement of coarse aggregate will decrease the density of concrete and increases the strength slightly. Durability of the concrete also has an increased value. Therefore it is giving an area to make a parametric study with the different propositions of replacement of coarse aggregate. In most of the cases, polystyrene is used as the coarse aggregate replacer. Our objective for research is fixed with this literature review.[5]
6. **Surya Man Koju (April 2017) :**They concluded that Thermal conductivity of EPS based lightweight concrete sandwich panel at room temperature is found to be 0.14 W/(m.K) which is nearly three times less than that of common building brick. Thermal conductivity varies, however, according to the significant change in source temperature. At extreme temperature it may reach up to 0.65 W/(m.K). Thermal resistance of 90 mm panel is found nearly 1 m2.K/W at room temperature, which quite desires insulation property in building materials in many situations. It can be said that from thermal insulation point of view, EPS based lightweight concrete sandwich panel is much better than common brick for building partition walls.[6]

3. METHODOLOGY AND MATERIALS

3.1 MATERIALS USED

A. **Cement:** Ordinary Portland Cement (OPC) of 'ULTRATECH CEMENT' brand was used during the study. The OPC used of grade 53 complied with the Type I Portland cement as in IS: 1489 Part (I):1991.

B. **Sand:** Locally available river sand passing through 4.75 mm sieve was used as fine aggregate in mortar for encasement. Initially the sand was dried in an oven at the temperature of 105 0C ± 5 0C. After that it was sieved accordingly. The sand used was as per the specifications of IS 1542(1992). The fineness Modulus was found to be 2.36.

C. **Water:** Water is one of the most important constituents without which mortar cannot be produced. It should not contain any substance, which can be harmful to the hydration process of cement and durability of mortar. In general, water, which is acceptable for drinking, is also suitable for the concrete mixing. In this study tap water was used for the preparation of the mortar

D. **Expanded Polystyrene:** EPS sheets having width 35mm, 20mm, 10mm were used as central core in Lightweight Sandwich Concrete Blocks.

EPS Sheet

3.2 MIX DESIGN

The mix proportion for conventional **M25 grade concrete** was derived as IS 456-2000.Type of cement was **OPC 53 grade.**

W/C Ratio	Cement (kg)	Sand (kg)	Aggregates (kg)
0.4	1	1.5	2.5

During experiment we required 20 litres water, 50kg of Cement, 45kg of Sand, 90kg of Coarse Aggregate.

It has been found that density of concrete increases with increase in cement volume. Experiment show that as the EPS sheet width goes on increasing the volume of cement required as well as amount of aggregates required goes on decreasing thus decreasing the density.

Casting of Blocks (190mmX90mmX55mm)

Concrete blocks were made using EPS (thermocol) sheet of different length and thickness. Thermocol Sandwich Concrete Block were cured for 24 hours after casting.

3.3 MIXING AND PROCEDURE OF THERMOCOL SANDWICH CONCRETE BLOCKS

To perform different test, blocks were prepared using molds. Block size were 190mmX90mmX55mm were prepared manually by using EPS (thermocol). During preparation of blocks, no bounding material was used. Cement of OPC 53 grade and crushed sand was used and W/C ratio 0.4 was used for making mortar. The mortar mixing was carried out by conventional method of mixing. To compare results of EPS blocks, conventional bricks of size 190mmX90mmX55mm were casted.

Mold for casting concrete blocks

Dry mix containing cement, sand, coarse aggregate was prepared and mixed for about 2 minutes. It was then transferred into molds kept on vibrator machine for minute.

3.4 PROCEDURE

- Place the molds on vibrating machine and pour wet concrete mix inside the mold into two layers with EPS in between.
- Vibrate the concrete through the table vibrator
- Vibration should not be more otherwise, segregation will occur.

- Also, EPS sheets of different length and thickness were used, during casting we observed that if the thickness of sheet exceed above 3.5 cm, during vibration it would come to the top leaving the concrete mix down and also cause bleeding.
- During casting we made Concrete Sandwich Block without using any bounding materials.
- After filling molds with wet concrete and EPS sheet, level the surface and designation to each specimen, Demold the specimen after 24 hours.

Designation given to blocks

4. TEST CARRIED ON THERMOCOL SANDWICH CONCRETE BLOCK

The blocks were cured for 7 days and were tested using compression testing machine. The load was applied until the block failure.

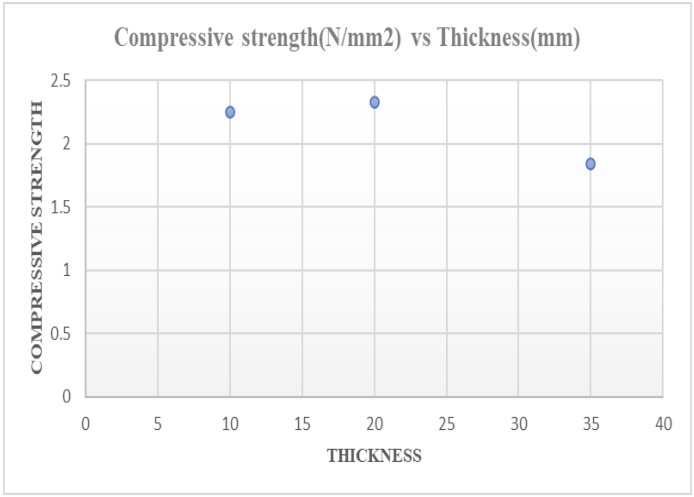
1. Compression Strength Test
2. Water Absorption Test

5. RESULTS

5.1 COMPRESSION STRENGTH TEST ON EPS BLOCKS

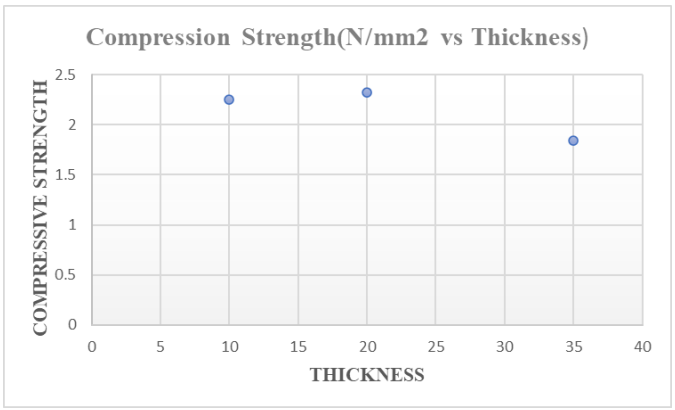
A. Testing on EPS Blocks having dimensions-
1.150mmX70mmX35mm
2.150mmX70mmX20mm
3.150mmX70mmX10mm

THICKNESS (mm)	COMPRESSIVE STRENGTH(N/mm2)
35	1.5
20	1.942
10	2.042



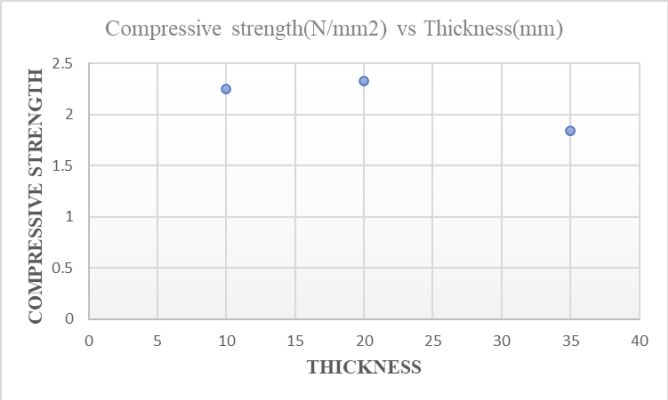
B. Testing on EPS Blocks having dimensions-
1.130mmX70mmX35mm
2.130mmX70mmX20mm
3.130mmX70mmX10mm

Thickness(mm)	Compression Strength(N/mm2)
35	1.842
20	2.326
10	2.254



C. Testing on EPS Blocks having dimensions-
1.110mmX70mmX35mm
2.110mmX70mmX20mm
3.110mmX70mmX10mm

THICKNESS(MM)	COMPRESSIVE STRENGTH(N/MM2)
35	1.852
20	1.98
10	1.942

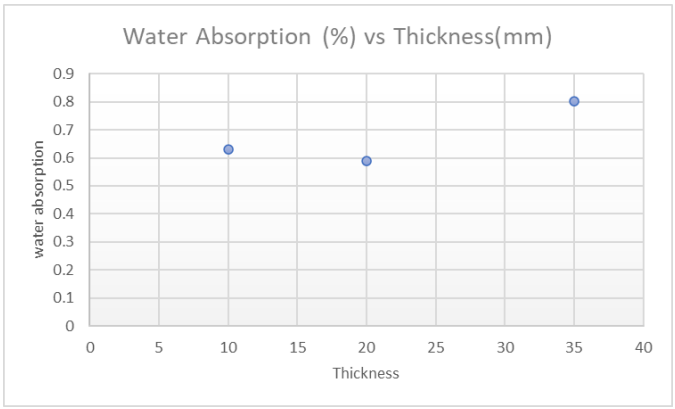


From the above performed experiments, it is observed that concrete block with EPS Sheet size 150mmX70mmX35mm have less compressive strength (1.5 N/mm2) as compared. Hence, as the sheet size increases there is decrease in density of cement as well as decrease in amount of aggregates used thus leading to decrease in compressive strength. Whereas, concrete block with EPS sheet size 130mmX70mmX20mm have more compressive strength (2.326 N/mm2).

5.2 Water Absorption Test on EPS Blocks

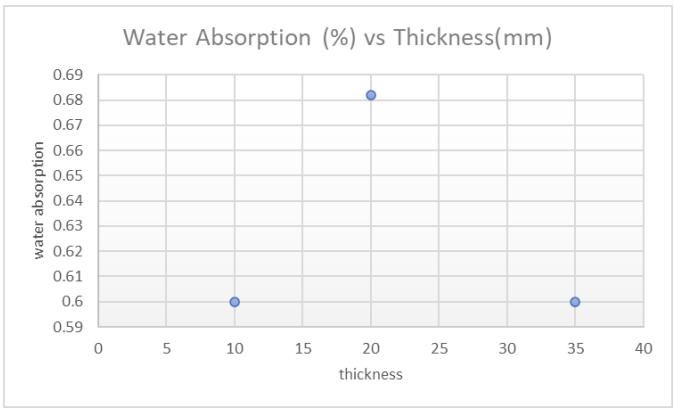
A. Testing on EPS Blocks having dimensions-
1.150mmX70mmX35mm
2.150mmX70mmX20mm
3.150mmX70mmX10mm

Thickness(mm)	Water Absorption (%)
35	0.802
20	0.59
10	0.63



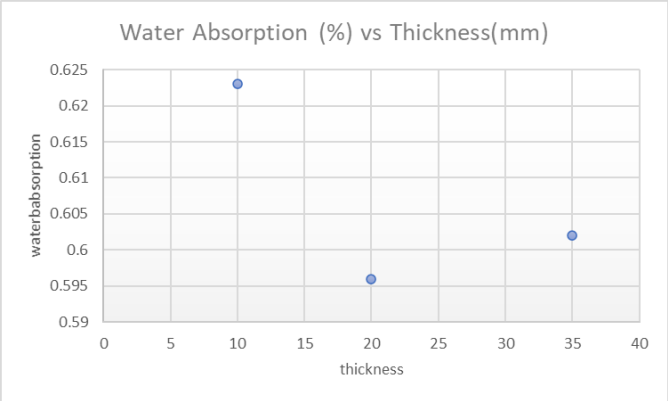
B. Testing on EPS Blocks having dimensions-
1.130mmX70mmX35mm
2.130mmX70mmX20mm
3.130mmX70mmX10mm

Thickness(mm)	Water Absorption (%)
35	0.6
20	0.682
10	0.64



C. Testing on EPS Blocks having dimensions-
1.110mmX70mmX35mm
2.110mmX70mmX20mm
3.110mmX70mmX10mm

Thickness(mm)	Water Absorption (%)
35	0.602
20	0.596
10	0.623



COMPRESSION STRENGTH TEST: - Average compressive strength of Thermocole Sandwich Concrete Block is **1.96 N/mm2**

WATER ABSORPTION TEST: - Average water absorption of Thermocole Sandwich Concrete Block is **0.64%**

CONCLUSIONS

The paper mainly examines the properties of Thermocol Sandwich Concrete Block. Based on the limited study done on project, following conclusions are drawn.

1. We have observed that, the use of EPS sheet in Concrete Blocks have led to achieve good compressive strength as well as better water absorption properties. Also, it is lightweight as compared to other building properties.
2. It is easy in handling. This reduces the cost and significantly cuts down the construction time.
3. We have also observed that, if the sheet size increases above 30mm there is decrease in its compressive strength.
4. Thermocol Concrete Sandwich Block shows good workability without using any bonding material also.
5. It has less water absorption than conventional brick masonry. It also has less density than conventional brick construction methods.
6. It also serves as a solution for EPS (thermocole) disposal thus, proving ecofriendly method of construction.
7. Obtained results also suggest that EPS concrete block has scope for nonstructural construction applications, like wall panels, partition walls, etc.

Thermocol Sandwich Concrete Block hence proved to be cheaper method of construction.

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