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Comparative Study of Properties of EPS with Regular Construction Materials

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Abstract - Expanded Polystyrene, often referred to as EPS, is a kind of rigid, closed cell foam plastic. EPS properties have a low thermal conductivity, high compressive strength, is light weight, inert. It can be used as a building material or a design element, and can be molded into many shapes for a number of household uses as well. 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. For further and smooth conduct of the project we contacted Associates named V.DAS Associates they provided us the required help. After receiving the Sample we prepared them in the shape of the sample used in normal construction practices. We studied the literature review and did the analysis about the EPS materials. We performed the testing that is discussed in detail. At the end Results and Analysis was done.

Key Words: EPS, shotcreting, RCC, estimate, etc.

1. INTRODUCTION

Due to the rapid increase of population, the construction industry is facing a new challenge. This challenge is to construct new, cost-effective building systems to satisfy the tremendous demand for low-cost housing. The building systems must be structurally stable, should allow fast and easy erection with unskilled labors and provide good thermal and sound insulation.

India is a rapidly urbanizing country facing development challenges associated with rapid growth. The high percentage of labor migration from rural areas to cities has contributed to urban congestion, pressure on basic amenities such as water and sanitation, etc., and most of all, housing shortages in cities across India. At the national level, the government estimated a shortage of more than 18.78 million homes at the beginning of 2012. Further, the country's total urban housing shortage is projected to be about 30 million by 2022. This ever increasing gap between demand and supply in the affordable housing segment is forcing people to live in slums and informal settlements. It is evident that the issue, if not dealt with effectively, can have tremendous negative impact on the country's economic growth and poverty reduction efforts. As construction industry facing this challenge to construct new, cost effective building system to satisfy demand for low cost housing.

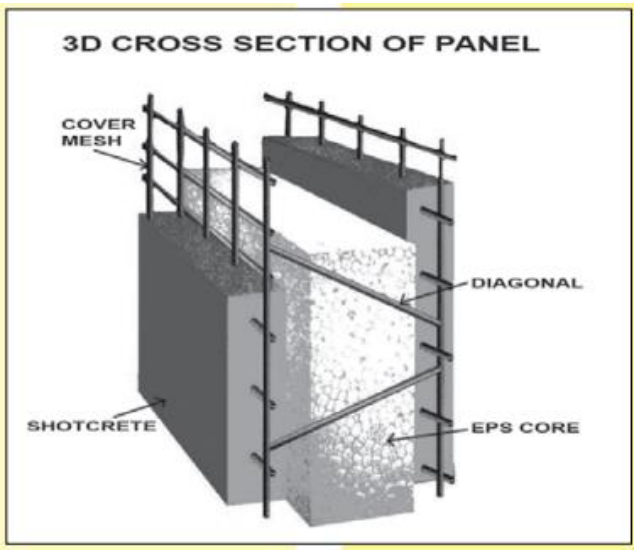


Fig –1: Cross-Section of EPS Panel

2. OBJECTIVES OF THE RESEARCH

i. To study the EPS core panel system for construction of affordable housing.

ii. To assess compressive behavior of concrete block with expanded polystyrene as a filler material.

3. PROPERTIES OF EPS

Expanded Polystyrene, often referred to as EPS, is a kind of rigid, closed cell foam plastic. EPS properties have a low thermal conductivity, high compressive strength, is light weight, inert. It can be used as a building material or a design element, and can be molded into many shapes for a number of household uses as well.

i. Density – EPS density can be considered the main index in most of its properties. Compression strength, shear strength, tension strength, flexural strength, stiffness and other mechanical properties depend on the density. The cost of manufacturing an EPS is considered linearly proportional to its density. Non-mechanical properties like insulation coefficients are also density dependent. Density of EPS shall be 15, 20, 25, 30 or 35 kg/m^3 according to IS4671:1984.

Table -1: ASTM C 578-95 EPS Densities

Test	Density Kg/m^3
XI	15
I	18
VIII	29

ii. Durability – No deficiency effects are to be expected from EPS fills for a normal life cycle of 100 years.

iii. Acoustical properties – Expanded polystyrene, when used in combination with other building materials effectively reduces the transmission of airborne sound through partitioned walls, ceilings and floors (Huntsman, 1999g). EPS has the advantage of being lightweight and effective in thicknesses as low as 0.625 cm it can replace thicker, heavier materials.

iv. Thermal conductivity – The thermal conductivity at 0°C and 10°C, respectively of the material shall not exceed the values given below according to IS:4671-1984, determined in accordance with the method prescribed in IS : 3346-1980.

Table -2: Bulk Density and thermal conductivity of EPS

Bulk Density (kg/m^3)	Thermal conductivity mW/cm °C	
	0°C	10°C
15	0.34	0.37
20	0.32	0.35
25	0.30	0.33
30	0.29	0.32
35	0.28	0.31

v. Water absorption – The water absorption of expanded polystyrene is low. Although water absorption decreases as density increases.

Table -3: % Volume of Water Absorption

Density	After 7 Days	After 1 Year
15	3.0	5.0
20	2.3	4.0
25	2.2	3.8
30	2.0	3.5
35	1.9	3.3

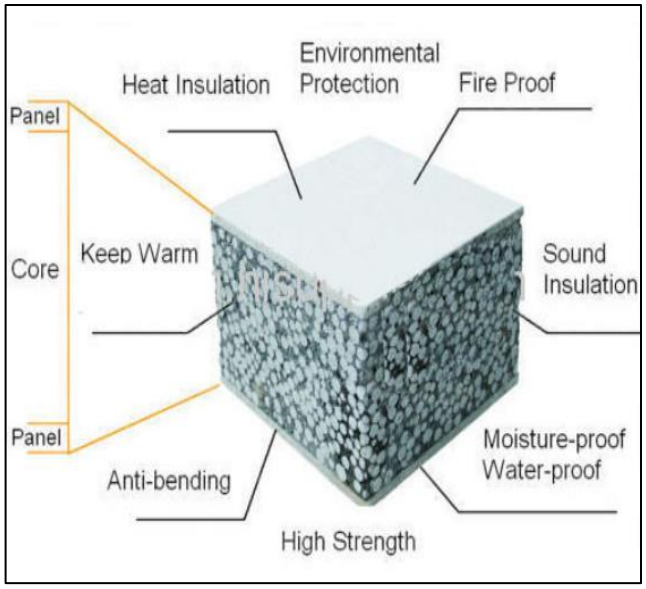


Fig –2: Properties of EPS Panel

4. PHASES OF ANALYSIS

i. Material Preparation - Material required for the preparation of concrete such as cement, fine aggregate and course aggregate and EPS material are obtained from their respective sources. In this study the EPS material that was ordered form the building consultancy V. DAS ASSOCIATES. Cutting and crushing was done as per the required testing and analysis.

ii. Preparation of specimen - Cement, fine aggregate and course aggregate of proportion 1:1.5:3 were taken volumetrically and dry mix was done. Expanded Polystyrene beads and Crushed EPS were also added to Water of required amount was taken and mixed thoroughly. The concrete mixing was carried out by conventional and normal method of mixing. All the ingredients of concrete with water were batched volumetrically and desired mix was prepared. The properties of fresh concrete were evaluated and tested for workability that is slump cone test and compaction factor test. Later on an EPS block was taken and was then embedded with Wire Mesh and a thin layer of plain cement slurry.

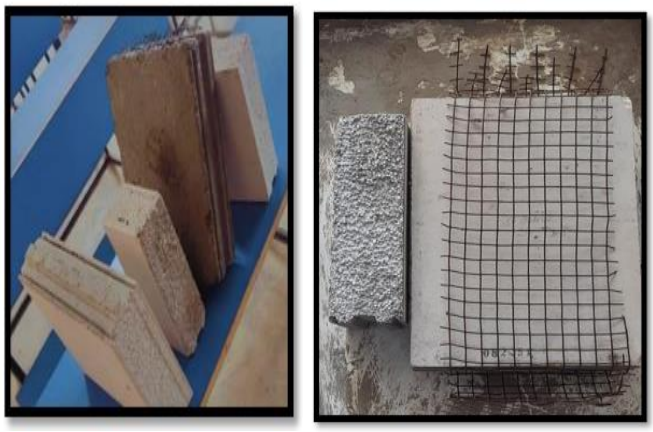


Fig -3: Preparation of Block with Wire Mesh & without Wire Mesh

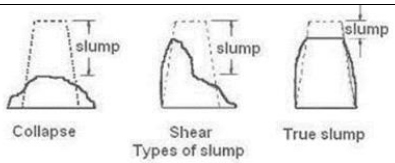
Fig -4: Block Prepared with EPS as Filler

5. TESTING ON SPECIMEN

i. Slump Cone Test- The slump test is a measure of the workability of the concrete. The apparatus for conducting the slump test basically consists of a metallic mould within the sort of a frustum of a cone. The cone was filled in 3 layers, each layer approximately one- third the volume of the mould. Each layer is tamped 25 times by a tamping rod. After the top layer has been compacted, the concrete is struck off level with a trowel and tamping rod. Remove any excess emission of concrete from around the base of the cone and lift the cone clear of the concrete allowing the concrete to settle or slump under its own weight. Slowly lift the cone vertically, with the lifting operation taking approximately 3 to 7 seconds. The amount of slump is measured immediately after the mould is lifted by placing the rodding bar across the inverted mould and measuring from the top of the mould to the displaced original center of the top of concrete. The difference in level between the height of the mould and that of the maximum point of the subsided concrete is measured. The change in height in mm is taken as a slump of concrete.

Fig -5: Slump Cone Test with EPS as a component

Table -4: Slump Cone Test Results

Standard Slump Cone Scenarios	With EPS
	Slump value - 120 mm i.e. 12 cm Type of Slump - TRUE SLUMP

ii. Impact Value Test- The aggregate impact value gives a relative measure of the resistance measure of the resistance of an aggregate to sudden shock or impact, which in some aggregate Differs from its resistance to a slow compressive load. A testing machine weighing 45 to 60 kg and having a metal base with a plane lower surface of not less than 30cm in diameter. Level and plane concrete floor of minimum 45 cm thickness are used to support it. The base of the machine should also have provisions for fixing its base. A cylindrical steel cup of internal diameter 102 mm, depth 50mm and minimum thickness 6.3mm. A metal hammer or tup weighting 13.5 to 14.0 kg the lower end is cylindrical in shape, is 50mm long, 100.0mm in diameter, with a 2mm chamfer at the lower edge and case hardened. The hammer is arranged in such a way that it should slide freely between vertical guides and be concentric with the cup. It is arranged that the free fall of the hammer should be within 380±5 mm. A cylindrical metal measure having an internal diameter of 75 mm and depth 50 mm for measuring aggregates. One end rounded tamping rod 10 mm in diameter and 230mm long. A balance of capacity not less than 500 g, and readable and accurate up to 0.1 g.

Fig -6: Sample For Impact Value test

Table -5: Impact Value Test Results

Agg. Impact value	Classification	Test Results
< 20%	Extremely Strong	
10 – 20%	Strong	
20 – 30%	Satisfactory for Road	
>35%	Surfacing	

iii. Compressive Strength Test - The test is conducted on "Universal testing machine". By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm x 15 cm x 15 cm or 10cm x 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of this specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen.

Fig -7: Compressive Strength Testing on EPS block with & without Wire Mesh

Fig -8: Compressive Strength Testing on Concrete block with EPS as a Filler material

Table -3: Compressive Strength Test Results

Sr. No.	Type of Sample	Test Results
1	EPS Block with a Wire Mesh of 3mm diameter	7 N/mm^2
2	Concrete block with EPS as filler material	4.44 N/mm^2
3	EPS block with a size resembling a brick	20 N/mm^2
4	Concrete block with EPS as a replacement	10 N/mm^2

6. DISCUSSION

i. The Slump Cone Test results have shown that it has a true slump and that shows that EPS has good cohesive and binding properties.

ii. As EPS is also used in road construction we thought of testing its impact value.

iii. Its impact value shows are cannot be used in the road construction as a major material and probably using sheets can be a solution for small area for road.

iv. As EPS is replacing many regular construction materials we tested the samples by making them in the size of the materials used such as bricks concrete blocks etc.

v. In Compressive strength test we found that smaller the area betters the strength as it is very compacted material.

7. CONCLUSION

After the cost comparison study many points were found out and the following comparisons were drawn:

1. EPS core panel system is a modern, efficient, safe and economic construction system for the construction of buildings. It has got the potential in achieving the Government of India's ambitious project "Housing for all by 2022"
2. As noticed in research papers and in the experimentation study It has a very high binding and cohesive because of the presence Potassium (K), Silica (Si).
3. The strength of the block that has 100% EPS in is it 10 N/mm^2 and the mould that has EPS in it as a filler material has strength 4.44 N/mm^2.
4. The Slump was a true slump hence shows its good binding and cohesive properties.
5. On the basis of tests done we can say that as the size keeps on increasing the strength keeps decreasing.

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