A Study on Application of Reinforced Expanded Polystyrene Wall Panel Technology

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Abstract— It is not possible to build a house for human being at affordable cost and at rapid or faster way. In India there is huge housing shortage for urban & rural. Due to group of low income of human being it is not possible or it is difficult to build an economical house. The material required for construction of building are on high demand, as they are back bone of construction activity. Also the cost of construction, time required to complete the project, due to dubious climatic condition, varying workmanship and unanticipated inflate in material cost is major problem. To fulfill these all basic needs, India requires new innovative, energy efficient building material for strong & long life housing in rapid track construction method at affordable cost. Therefore one such material is reinforced expanded polystyrene wall panel, which is better replacement to the conventional building material. This lightweight reinforced expanded polystyrene wall panel provides faster construction & contributes to environmental protection, can give a solution to any of the above issues and concerns. An investigation focused on the strength capability of lightweight sandwich wall panel, method of construction & its properties. Additionally, this EPS panel deals with problem of connection for diagonal shear reinforcement & cover over the EPS .This problem can be avoided by placing the mild steel bars above the EPS & below the welded galvanized steel mesh .Also study deals with reinforced EPS wall panel strength under flexural loading (one point load) by treating these EPS panel as floor also studying strength under axial load by treating these EPS panel as a wall. It is found that cost of material for construction of building using reinforced PES technology is lesser than the brick wall construction. This Reinforced Expanded Polystyrene Technology gives a chance to meet the housing demand at the lower cost. Thus we aim to prove that by using Reinforced Expanded Polystyrene Technology as an alternate building material, we can achieve an easy, rapid & economical method of construction.

Key words: Expanded Polystyrene Panels, Alternative Materials, Compressive Strength, Flexural Strength, Water Absorption & Density

I. INTRODUCTION

The initial basic needs of human being are food, water, clothing & shelter. In this 21st century housing demand has risen due to rapid population growth & 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 & economical house at minimum time requirement &at affordable cost, but it is difficult by using traditional construction material & methods.

To overcome these issues and achieve the economical practices, this research focuses on Reinforced Expanded Polystyrene wall panels as a possible substitute to the conventional building materials & methods. EPS wall panel 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 & they are taken directly on the site for assembling & then taken for plastering or shortcreting. Also the EPS panels made on site, making assemble & then plastering or shortcreting is done.

In the traditional construction method i.e. R.C.C, brick masonry & rubble masonry construction, self-weightof structure is huge. Thus reduction in self-weight of structure results in the reduction of c/s size of foundation & other structural elements & there by reduced total cost of the project. Sandwich wall panel consist of EPS as central core, welded galvanized steel mesh & finishing outer core on both side as cement mortar plaster. The EPS causes serious environmental problem as this is non-biodegradable material. It is one of the material which is source of pollution. Thus we can adopt this EPS as a construction material. This is alternative material for replacement of brick wall. This Reinforced Expanded polystyrene Technology can be used as wall panels, floor panels, roof panels, stair, room sized components, door frame, pile, foundation & even entire building.

II. LITERATURE REVIEW

P. Poluraju, G. Appa Rao [2014] tested the EPS wire mesh panels on a comprehensive review of state of art on the performance of EPS wire mesh panels for structural applications under general loading. Axial compression strength of EPS wall panel depends on compressive strength of concrete and aspect ratio of the wall panel, whereas shear strength of EPS wire mesh panels depends on the number of diagonals (100 or 200 diagonals per square meters).

Piyush Bhandari [2016] In this paper Piyush Bhandari take the different tests on EPS panels. And he investigated that the strength of EPS panel is higher than the other conventional building material. This paper mainly examines the properties of sandwich panels. The use of Thermocol core along with wire mesh layers have helped to enhance property of precast wall panels. He also compared with conventional building method it is less time consuming & also cost effective. It has less water absorption than conventional brick masonry.

Pradeepa. S , Anitha. J, N. Tamil Selvi, Pranav. P, Arpit Jaketia [March 2016] In this paper studied that, Reinforced Thermocol Panel offers high bending stiffness at low densities due to minimal compressive and flexural strength. The cost of the construction using thermocol lesser than conventional or traditional building material. The

flexural tests conducted on EPS panels under one point loading and two point loading.

Nahro Radi Husein et al., [2013] In this paper investigate the strength capability of lightweight web sandwich panel (LWSP) in terms of first crack load, load-deflection curve for flexural load with (one point loading and third point loading), modules of rupture, ultimate flexural load, axial load-deformation curve and the failure mode. The unit weight of the LWSP's which have aerated concrete as a core is (1850-1950) Kg/m3 and the unit weight of the LWSP's which have thermocol as a core (1250-1300) Kg/m3.

Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade, Sangram Naik, Amruta Kulkarni [2015] In this paper he performed experimental investigation of engineering properties such as compressive strength, modulus of elasticity, drying shrinkage and creep, of expanded polystyrene (EPS) aggregate concrete varying in density. Cost of EPS is less compared to that of normal concrete. Increase in the EPS beads content in concrete mixes reduces the compressive and tensile strength of concrete. All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.

Expanded Polystyrene: Expanded Polystyrene (EPS) is a lightweight cellular plastic material consisting of small hollow spherical balls. It is an incredibly flexible material that is widely used for building and construction products. The technology has been found to be cheaper than the conventional method of construction using brick and mortar. The products consist of lightweight foam blocks made of EPS which are cut into panels (single or double depending on design requirements) prefabricated in the factory, and are stacked together to make up the desired wall shapes which are then coated with cement mix or filled with concrete. These materials are used to build single level and multilevel walls, slabs, retaining walls and under floor insulation panels for heating, cooling and sound insulation. EPS is a cost effective material for thermal and sound insulation.

III. Experimental Programme

The experimental programme was carried out in two stages. The first stage included testing the physical properties of materials used in mortar to plaster the different panel. The second stage of the testing included of testing of EPS wire mesh panel with normal conventional brick panel. Initially the physical properties of the materials used in panel were tested, following are the tests conducted on material.

A. Cement

Ordinary Portland Cement (OPC) of was used to the study. The OPC used of grade 53 Grade as per IS: 1489 Part (I):1991

1) Fineness of cement (IS:4031-Part 3, 1988)
2) Standard consistency of cement (IS:4031-Part4-1988)
3) Initial setting time test (IS:4031-Part 5, 1988)
4) Final Setting time test (IS:4031-Part 5, 1988)

B. Fine Aggregate

Locally available river sand passing through 4.75 mm sieve was used as fine aggregate in mortar. The sand used was as per the specifications of IS 1542(1992).

1) Sieve Analysis of fine aggregate (IS 383)
2) Specific Gravity & Water absorption of fine aggregate (IS: 2386 Part III: 1963).

C. Clay Brick

The clay bricks of size 190mm× 90mm× 90mm used during the study & comparing results with EPS Panel. (IS 1077 (1992))

1) Compressive Test
2) Water Absorption Test

D. Expanded Polystyrene

Expanded Polystyrene sheets having width of 50mm were used as central core.

E. Galvanized Welded Steel Mesh (1m x 6m Roll 25mm×25mm mesh 1.6mm)

Welded wire mesh, or welded wire fabric, or "weld mesh" is an electric fusion welded prefabricated joined grid consisting of a series of parallel longitudinal wires with accurate spacing welded to cross wires at the required spacing. The steel mesh has average diameter 1.6 mm. Square wire mesh is having opening 25mm ×25mm.

F. Water

Water is one of the most important constituents without which mortar cannot be produced. In this study tap water was used for the preparation of the mortar.

IV. Preparation of Reinforced EPS Panels & Conventional Brick Panels by Using Normal Cement Mortar

To perform different tests, Panels are prepared in Cube and beam mould. The panels size were 150mm×150mm×75mm and beam size were 300×100×75mm.The panels of size 150mm×150mm×75 mm are prepared manually by using EPS, Galvanized welded mesh and Binding Wire. Cement of OPC 53 grade cement and natural sand was used and water to cement ratio of 0.4 was used for making mortar mix. The mortar mixing was carried out by conventional method of mixing. All the ingredients of mortar was taken by weigh batching. The desired quantities of the mix were mixed accordingly. To compare the results of EPS Panel to conventional brick panel, the brick panels of size 200mm×100mm×100mm were made.

Fig. 1: EPS Panel of size 150mm×150mm×75mm

Fig. 2: EPS Panel of size 300mm×100mm×75mm

Fig. 3: Plastering of EPS Panels

Fig. 4: Plastering of Brick Panels

V. TESTING OF PREPARED EPS PANELS & CONVENTIONAL BRICK PANELS

The panels were cured for 14 days and were tested in universal testing machine under axial loading. The load was applied till the panel failure.

1) Compressive Strength Test
2) Flexural Strength Test
3) Water Absorption Test
4) Density Test

A. Compressive Strength Test

1) Compressive Strength Tests on EPS Panels:

Fig. 5: Compressive Strength Tests on EPS Panels

The Average compressive strength of EPS Panel = 3 N/mm^2

B. Flexural Strength Test

1) Flexural Strenth Test on EPS Panel:

Fig. 6: Flexural Strenth Test on EPS Panel

The Average Flexural strength of EPS Panel = 5.91 N/mm^2

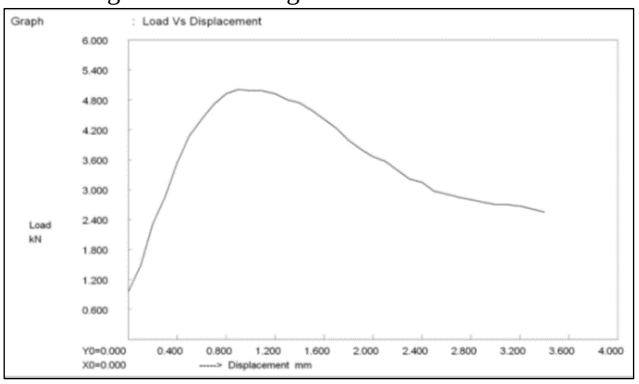

Fig. 7: Load vs. Displacement Graph of Flexural Test of EPS Panel

2) Compressive Strenth Tests on brick Panels:

The Average compressive strength of Brick Panel = 0.98 N/mm2

D Flexural Strength Test of Brick Panel

The Average Flexural strength of EPS Panel = 2.55 N/mm2

C. Water Absorption Test

A. Water Absorption Test on EPS Panel

The Average Water Absorption of EPS Panel is 6.92%

B. Water Absorption Test on Brick Panel

The Average Water Absorption of Brick Panel is 13.23%

D. Density Test

Density test of EPS Panel

The Average value of Density of EPS Panel is 1551.56 Kg/m3

Density Test on Brick Panel

The Average value of Density of EPS Panel is 1812.35 Kg/m3

VI. TEST RESULTS

Test results of various tests are mentioned in the following tables

Sr. No	Tests Conducted	Test Result
1	Fineness of cement	2.42%
2	Standard Consistency	26%
3	Initial Setting Time	35 Minutes
4	Final Setting Time	185 Minutes

Table 1: Test results on cement

Sr. No	Tests Conducted	Test Result
1	Sieve Analysis	Grading Zone II
2	Specific Gravity	2.65
3	Water Absorption	0.80%

Table 2: Tests results on fine aggregates

Sr. No	Tests Conducted	Test Result
1	Compressive Test	1.88 N/mm^2
2	Water Absorption	10.86%

Table 3: Tests on Conventional Bricks

Sr. No	Tests Conducted	Test Result
1	Compressive Test	3 N/mm^2
2	Flexural Strength Test	5.91N/mm^2
3	Water Absorption	6.92%
4	Density	1551.56Kg/m^3

Table 4: Tests on EPS Panels

Sr. No	Tests Conducted	Test Result
1	Compressive Test	0.98 N/mm^2
2	Flexural Strength Test	2.25 N/mm^2
3	Water Absorption	10.2%
4	Density	1812.35 Kg/m^3

Table 5: Tests on Brick Panels

VII. CONCLUSION

Based on the experiment programmers following conclusions are drawn, the cement tested was showing the suitable results to carry out the further experimental programmer. Fine aggregate testes showed the better results to form a good mortar.

As we are compared the results of EPS Panel with conventional Brick Panel.The results of EPS Panel are better than the conventional Brick Panel.The Compressive Strength of the EPS Panel is more than the Conventional Brick Panel.The Flexural Strength of EPS Panel is more than the Conventional Brick PanelThe

Water Absorption of EPS Panel is less than the conventional Brick Panel; therefore we are assured that EPS Panel has less water absorption capacity. The average water absorption of EPS panel is 6.92% which is good as compared to conventional Brick Panel & hence it is normal. At time of oven drying at temperature 105+ 5 degree centigrade to panel, The EPS Panel is not burn at high temperature hence it withstands with high temperature.The Density of the EPS Panel is less than the conventional Brick Panel. Therefore it can be handle very easily.

The Reinforced Expanded Polystyrene (EPS) wall Panel construction is compared with conventional building material i.e. Brick Panel is studied briefly. Also properties of EPS Panel are compared with conventional brick Panel. The EPS panels, which are extremely strong yet lightweight, compared to conventional Brick Panel, are ideal for a wide range of building applications.

This technology reduces cost of construction and significantly minimizes the building time. In the development of new low energy, low cost, environmentally, ecofriendly and ecologically sound housing solutions for the 21st century, EPS wall panel is the ideal product for re-housing and for new housing or industrial construction.

As compared to conventional building method it is less time consuming & also cost effective. Also it saves major building materials. It is very useful where the other building materials are not easily available. It is environment friendly. EPS wall panels are useful where there is need of quickly rehabilitation.

It has also has less density than conventional methods. So it is more advantageous and light in weight. The conventional method of construction using brick or stone masonry is more labor intensive, labor proved to be more costly than using EPS wall panel technology. EPS panels are most suitable for thermal insulated wall due to the presence of polystyrene in the panel. All the above properties make EPS panels as the best suitable replacement for conventionally adopted wall construction methods.

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