A Replacement for Conventional Building Materials by EPS-Wire Mesh Panel
Akshay Kumar Bacha1, Rahul Patil2, Shrinath Hogade3

Abstract
Building construction is an excellent paragon for the development of a society, which fulfils the most basic needs of a human being in terms of shelter and building infrastructure. The conventional building materials are in high demand as they are the back bone of constructional activities. The cost of construction, time taken to complete particular project due to dubious weather conditions, varying workmanship and unanticipated inflate in material cost is a major problem. Hence there is a need for a new alternative material to boost up the constructional techniques. One such material is EPS wire mesh panel, which can be a good replacement to the conventional building materials. In the present study an attempt is made to understand the strength behaviour of the EPS wire mesh panel with normal conventional concrete by varying the thickness of plaster, and is examined under compression loading. Since the number of joints in an EPS Panel when used for wall construction will be less hence the strength of wall marginally increases.

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Keywords
EPS Panel
Alternate material
Strength properties
Sustainability

License

INTRODUCTION
The demand for construction materials is on the boom as the constructional activities are taking place at a high rate. The high speed technology adopted in construction industry and the urge for new construction materials go hand in hand. The main cause for this demand is being the increase in population and to fulfil the demands of the society, and also to facilitate proper infrastructure. The conventional materials are being used since ages of time to accomplish the constructional needs. Nature is the main source for these conventional building materials. Due to the illegal and uncontrolled use of these materials, scarcity of the materials and ill-effect on nature did arise.
To counteract the above cause the need for new building materials arose, technologies which will sustainably diminish the short comers of natural building materials and put forward to boost the construction activities. As a way of finding solution to these housing challenges, this research considers EPS wall panel as a possible substitute to the conventional building methods. As panelized construction is much easier than the conventional constructional methods, EPS wall panels can emerge out as a better option for modern construction. Panelized construction is a process of structured construction in which the structure is subdivided in to basic planar elements that are typically constructed under some form of mass production and then transported directly to the construction site and assembled to form a finish structure.
Polystyrene can either be solid or foamed. Polystyrene foam is a lightweight, rigid plastic insulation material, produced either as EPS (Expanded Polystyrene) or as XPS (directly Extruded Polystyrene). In the nineteenth century, researchers seeking materials suitable for making film, carriage windshields, and various small items such as combs produced early plastics out of natural substances and chemicals. In making these plastics, the scientists exploited the natural tendency towards polymerization, in which two or more small molecules, or monomers, combine to form chains that are often very long. The resulting molecular chains, or polymers, comprise repeating structural units from the original molecules. Polystyrene is among the best known synthetic polymers.
Expanded polystyrene (EPS) represents such materials those have found their way into the previously conservative construction industry. Plastics are typically polymers of high molecular mass and may contain other substances to improve performance and reduce production costs. Monomers of plastic are either natural or synthetic organic compounds. With the proven strengths of plastic materials, its use in commercial and residential construction has dramatically surged in the last 30 years due to improved material performance. Efficient use of technologies in new applications and the need for lightweight and durable materials for insulating and construction purposes dramatically surged. Polystyrene is one of the most widely used plastics, the scale being several billion kilograms per year. The polystyrene foam is a thermoplastic material obtained by polymerization of styrene.
An EPS wire mesh panel consists of a polystyrene core along with a cover mesh of zinc coated steel wire mesh, which are welded together with the same material of which the mesh is made. The standard widths of the panels are 1.0m or 1.20 m, and their lengths are variable which are usually co-ordinated with the usual storey heights, thus approx. 2.8m-3.0 m. A skeleton view of EPS wire mesh panel is represented in Fig.1.

LITERATURE REVIEW
P. Poluraju and G. Appa Rao [1] 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). The flexural strength of EPS wire mesh slab panels depends on shear span and degree of composite action. The seismic performance of buildings using EPS wire mesh panels is well understood that forces acting horizontally on EPS wire mesh panel buildings, due to earthquake forces, are transferred most effectively by EPS shear walls. A frame-like design of EPS wire mesh panel buildings with heavy reinforcement in the joints is not necessary. Especially in residential buildings a box-like EPS-structure is the best option to receive high strength and meet architectural requirements at the same time. For dimensioning, EPS wire mesh slabs and EPS wire mesh walls can be considered independently of each other.

D.A. Bournas [2] of European Laboratory for Structural Assessment (ELSA), Ispra, Italy and A. Pavese of University of Pavia, Italy have tested the behaviour of prefabricated reinforced concrete sandwich panels experimentally and analytically. Initially, tests were carried out on single full-scale reinforced concrete sandwich panels with or without openings, reproducing the behaviour of lateral resisting cantilever and fixed-end walls. The performance and failure mode of all panels tested revealed coupling between the flexure and shear response.

Anthony Nkem Ede and Abimbola Ogundiran [3] conducted extensive studies on thermal behaviour and admissible compressive strength of expanded Polystyrene wall panels of varying thickness and concluded that the admissible axial loads and thermal resistance offered by EPS panels are efficient enough to use the product as a good building material. Influence of eccentricity on the admissible axial load was also obtained. Results have shown a composite relationship between the two stages of testing the physical properties of materials used in panel were tested, following are the tests conducted on concrete:

CEMENT
OPC 43 Grade cement was considered for the experimental programme and the following experiments were carried out on cement:
- Initial setting time test (IS:4031-Part 5, 1988) [6]
- Final setting time test (IS:4031-Part 5, 1988) [6]

FINE AGGREGATE AND COARSE AGGREGATE
Fine aggregate was taken and tested as per the standards of IS: 2386-1963 [7], fine aggregate confirmed to Zone-II. Coarse aggregates were tested according to IS standards which are shown below. The physical properties for which the natural sand was tested are as follows:
- Sieve Analysis (Fineness Modulus)
- Bulk Density
- Specific Gravity

PREPARATION OF EPS WIRE MESH PANEL SPECIMEN BY USING NORMAL CONCRETE
The EPS panel of size 1mx1m was used for testing. The mix proportioning of 1:1.5:3 (IS: 10262-1982 (reaffirmed 1999)) [10] was adopted for preparing the concrete. Cement of OPC 43 grade cement and natural sand was used with 6mm sized coarse aggregates and water to cement ratio of 0.5 was used for making concrete mix. The concrete mixing was carried out by conventional and normal method of mixing all the ingredients of concrete with water and was weighed batched. The desired quantities of the mix were mixed accordingly. Properties of fresh concrete were tested for its workability that is slump and compaction factor test.

The concreting was done in layers for better adhesion, and was done for two thicknesses i.e., 25mm and 35mm. The completion of the first layer is shown in figure 4 below. And the finished plastered EPS panel is shown in figure 5.
**TESTING OF PREPARED EPS PANELS**
The panels were cured for 28 days and were tested in universal testing machine under axial loading. The load was applied till the panel failure. The schematic view of testing and the failure of the panel with normal concrete is show in following figures.

![Fig 5: Finished plastered EPS panel](image)

![Fig 6: Testing for EPS Panel](image)

![Fig 7: Failure of panel after testing](image)

**TEST RESULTS**
Test results of various tests are mentioned in the following tables.

**Table 1: Test results on cement**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Test conducted</th>
<th>Test results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fineness of cement</td>
<td>9%</td>
</tr>
<tr>
<td>2</td>
<td>Initial setting time test</td>
<td>34 minutes</td>
</tr>
<tr>
<td>3</td>
<td>Final setting time test</td>
<td>9 hours</td>
</tr>
<tr>
<td>4</td>
<td>Specific Gravity</td>
<td>2.91</td>
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</tbody>
</table>

**Table 2: Test results on fine aggregates**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Tests conducted</th>
<th>F.A Test Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sieve Analysis(Fineness Modulus)</td>
<td>2.40</td>
</tr>
<tr>
<td>2</td>
<td>Bulking</td>
<td>1.52</td>
</tr>
<tr>
<td>3</td>
<td>Specific Gravity</td>
<td>2.60</td>
</tr>
<tr>
<td>4</td>
<td>Bulk Density</td>
<td>1.64 gm/cc</td>
</tr>
</tbody>
</table>

**Table 3: Test results on coarse aggregates**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Tests conducted</th>
<th>F.A Test Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sieve Analysis(Fineness Modulus)</td>
<td>6.80</td>
</tr>
<tr>
<td>2</td>
<td>Aggregate impact value</td>
<td>11.61%</td>
</tr>
<tr>
<td>3</td>
<td>Aggregate crushing value</td>
<td>9.25%</td>
</tr>
<tr>
<td>4</td>
<td>Aggregate abrasion value</td>
<td>7.60%</td>
</tr>
</tbody>
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**Table 4: Tests on fresh concrete**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Tests conducted</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slump Test</td>
<td>90mm</td>
</tr>
<tr>
<td>2</td>
<td>Compaction Factor</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Table 5: Tests on fresh concrete**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Tests conducted</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slump Test</td>
<td>90mm</td>
</tr>
<tr>
<td>2</td>
<td>Compaction Factor</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Table 6: Results of tests conducted on EPS wire mesh panel by using 25 and 35 mm thick plaster**

<table>
<thead>
<tr>
<th>Compressive strength test</th>
<th>Result obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength at 28 days by using 25mm thick plaster</td>
<td>2.26 N/mm²</td>
</tr>
<tr>
<td>Compressive strength at 28 days by using 35mm thick plaster</td>
<td>2.64 N/mm²</td>
</tr>
</tbody>
</table>

**CONCLUSION**
Based on the experiment programmes following conclusions are drawn:
- The cement tested was showing the suitable results to carry out the further experimental programme.
- Fine aggregate and Coarse aggregates tests showed the better results to form a good concrete.
- The panels were tested with conventional concrete mix design and compressive strength of 2.26 N/mm² and 2.64 N/mm² were obtained for 25mm and 35mm plaster thickness.
- Since the number of vertical and horizontal joints can be minimized marginally by using the EPS panel in wall construction hence the strength is improved.
- As compared to the weight of conventionally built wall, EPS panel wall reduces the weight, so in construction of multi story buildings EPS panels can be considered as the best suitable replacement for conventional methods of wall construction.
- 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.

**REFERENCES**