

SIP CONSTRUCTION WITH EPS AND GALVANISED ELECTRO-WELDED MESH

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ABSTRACT:

SIP stands for structure insulated panels which is usually constructed of oriented strand boards (OSB) on the interior and exterior sides with foam like Expanded polystyrene (EPS), extruded polystyrene (XPS) or rigid poly-urethane foam, sandwiched in between the OSB sheets. Around the polystyrene; plywood, pressure treated plywood, aluminium, thin mesh of steel, stainless steel etc can also be used in replacement to OSB panels. This article focus on a new idea which is using polystyrene sheets 170mm thick, 2.4m long and 1.2m wide with 3mm electro-welded mesh on both faces with both main and distribution bars. Depending on the loading the spacing can be reduced and some extra bars at length $L/3$ can be welded to the mesh. The SIP with galvanized electro-welded mesh acts like RC structure and if installed by trained persons it is suitable for all design loads as all the factory tests have been conducted on them. The advantages of using SIP panels with electro-welded mesh are easy to install, economical (at least half a price of traditional build), speedy construction (takes about half of the time as compared to traditional build), light weight, fire resistant, flexibility, thermal properties, easy transportation etc.

Keywords:

Structure insulated panels (SIP), Electro-welded mesh, Oriented strand boards (OSB), Expanded polystyrene (EPS), Structural insulation panels association (SIPA)

1- Introduction:

SIP stands for structure insulated panels which is usually constructed of oriented strand boards (OSB) on the interior and exterior sides with foam like Expanded polystyrene (EPS), extruded polystyrene (XPS) or rigid poly-urethane foam, sandwiched in between the OSB sheets. Around the polystyrene; plywood, pressure treated plywood, aluminium, thin mesh of steel, stainless steel etc can also be used in replacement to OSB panels. Alden B. Dow, an American architect, in 1952, invented a new type of building structure system which is called structure insulated panel. In SIP construction, Dow used polystyrene which was manufactured in his own chemical's company i.e. Dow Chemicals. The houses constructed with SIP are cool in summer and hot in winter (Alden B. Dow, 1952). This idea of building was developing and progressing with the period of time. Nowadays people across Europe and UK are using this idea of construction with some modifications. As the SIP with OSB was considered to be costly that's why some companies across UK and Europe started to modify trying some more materials. One of the modification, which nowadays manufacturing company account for is, use of sheets of Expanded polystyrene with electro-welded mesh on both faces of polystyrene. And this is the topic, which this article will cover.

2- Literature Review:

SIP was introduced in 1935 at Forest Product Laboratory. The famous architect Frank Lloyd Wright used structure insulated panel in construction of some of the houses built in between 1930's to 1940's. Alden B. Dow, who did apprenticeship with Frank Lloyd Wright, followed the work of Frank and used his own company's manufactured polystyrene in construction of houses in 1952 and observed a very good thermal performance of SIP. Literally, Dow was the first one who used the first true SIP as construction material. The energy prices across the world went high in 1973, so this idea of building gained attention and people started building with SIP in US, Canada and later on throughout the Europe. In 1980, Oriented Strand Boards (OSB) were developed, in which polystyrene was sandwiched between OSB. So in this way, this economical material progressed and nowadays, it's widely been used in UK and Europe as construction member with some modifications. As it progresses more and more, so nowadays even no OSB's are used, instead galvanized electro-welded mesh are used on both sides and then shotcrete is applied on both sides.

In 1990, SIPA (Structural Insulation Panel Association) was established which was working as trade organization (Akay and Hanna, 1990; Basunbul et al., 1991; Johnson and Sims, 1986; Smith, 2011). Nowadays in UK and Europe, SIP construction is gaining interest of researchers and builders as its features of being cost effective, environment friendliness, easy handling, easy transportation, light weight, thermal insulation. Also builders and researchers are trying to modify it with new ideas. SIP is panel in which polystyrene is sandwiched and used as structural members like as roof, wall, floor for houses or low storey structures (Smith, 2011). In the last decade, numerous studies have attempted to investigate the behaviour of sandwich panels from different perspectives. From the last couple of years, researchers have investigated about the SIP's behaviour as building structural members (Dharmasena et al., 2011; Frostig and Thomsen, 2011; Hoo Fatt and Sirivolu, 2010; Kim and Lee, 2008; Malekzadeh et al., 2006; Wang et al., 2009; Yeoshua, 2009; Zhou and Stronge, 2006). SIP have good insulation properties (Little et al., 2002; Smith, 2011).

MODIFICATION IN SIP:

As SIP was considered as high costly as compared to traditional build, but nowadays a lot of modification has been done in SIP's. One of the most followed modification which is widely used in most parts of UK is use of sheets of polystyrene with galvanized electro welded steel mesh on both faces. And this is what this research paper is focusing on.

SIP with EPS and Electro-welded mesh:

The components of SIP with EPS is 170mm polystyrene with 3mm electro-welded mesh on both faces of polystyrene. The mesh is single with both main and distribution bars and can be doubled up depending on loadings. The spacing of the mesh depends on loading but commonly it is 10mm. The SIP's are 2400mm long and 1200mm wide, so in case of a long and wide structure we combine the sheets together and bind it with an extra electro-welded mesh extending them by $L/3$ on both sides to avoid negative moment.

Methodology:

The process for SIP construction is simple and easy. It just need a trained person who can align the SIP sheets accurately with different tools and then at the timing of finishing, apply proper finishing thickness.

1- How SIP works:

The SIP works like RC structure on low storey buildings like one or two storeys buildings, extension projects. This reduces the cost by about half of the cost that will be incurred by traditional build. Also this method of construction gives you a speedy structure about half less time consuming as of the traditional build.

2- Structural loads

SIP holds all the structural loads of the structure as per design, either the structure needs single layer of SIP sheet or multiple layers of sheets. Usually for two storey house or structures it needs a single layer of SIP. The loading calculations of SIP sheets on different projects have proved that it holds all the structural loads and the structure is sound.

Starting with the foundation, trench is excavated for the perimeter of building and inside the plan where it shows internal SIP partitions. RC is laid in the trench and the mild steel length of $L/4$ of clear height is erected at distance not less than 0.5meter centre to centre. The next step is to compact the internal ground by compacting machines and laying DPM sheet to stop moisture coming to structures and then SIP sheets as per designs are laid and the concrete is poured as per design and thickness. Picture A and B elaborate the process and use of SIP sheets in foundation more vividly.



Picture A



Picture B

SIP sheets are then tied to the mild steel erected from foundation to form walls as per plan and the process as explained in the section above is repeated, shotcrete is applied on the wall to make the walls solid like RC walls. SIP sheets are then installed on slab with extra electro-welded steel meshes tied in extending $L/3$ on both sides of SIP's to overcome negative moment. Shotcrete is applied on the slab to give you a finish product. Once the shotcrete dries up, gives a sound structure with-holding all the dead and live loads. The finishing as per architectural drawing is applied after the structure is ready. Picture C,D, E and F explain this process in more details.



Picture C



Picture D



Picture E



Picture F

Benefits of SIP panels:

The following are the benefits of using SIP construction with polystyrene and electro-welded meshes:

1- Low carbon

SIP panels with polystyrene generates less carbon CO₂ (33 KG CO₂ e/m²) and it saves about 65% of user energy in comparison with traditional homes.

2. Light-weight

The weight of SIP panel is light. It can be easily transported in van and can be handled manually. So, you don't need any tower or mobile cranes.

3. Speedy construction:

The structure can be built up with 50% less time as compared to traditional build.

4. Construction Cost:

Construction cost using SIP with polystyrene lessen to about half in comparison with traditional build.

5. Fire resistant:

The panels meet fire resistance standards and have an REI of 120 minutes.

6. Flexibility:

The panels can be cut to any shape, size on site or off-site which offers a complete variety of building elements like floors, ceilings, walls, retaining walls, curtain walls, stairs.

5. Loading:

The panels are tested and structurally sound for all types of loading i.e. Lateral loads (earthquakes, winds), dead and live loads

Projects in UK built from SIP:

The projects which have been completed with this material are:

1. Dwelling on Fern Road, Hastings:

The dwelling on fern road hastings was basement+3 structure, among which the basement, supported garage, flooring and walls were built up with SIP panels of polystyrene



2. Staircase project in West London

The requirement of this project was to install a staircase for a property along with one landing on the lower floor and one connecting with above floor. The stairs and landings were built up with SIP panels and then shotcreted.



3. Regal Hotel, Golders Green

Regal hotel in golders green was built up with SIP panels. The front of hotel was retained. The rare elevation was being built up with SIP panels as can be in photos.



4. House extension in Mountside, Guildford:

The 2 storey house extension in mountside Guildford was done with SIP panel comprising of a kitchen and living room on ground floor and a bedroom on the 1st floor.



5. House extension in Coworth, Sunningdale:

The house extension was done with SIP panel by 2 storeys including living room and a bedroom on ground and 1st floor respectively.



Limitations of research study:

1. As this is a new idea of construction so not a lot of research work has been done on the said topic
2. Limited timeframe
3. Construction with SIP panels is emerging in Europe as well but the projects which are discussed has been taken from England (London). Other research studies can refine and generalize it in other parts of Europe, USA, Canada, Australia, UK
4. Lack of resources

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