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Art of Review

LIGHTWEIGHT WALL PANELS

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Abstract:

The construction industry continually seeks innovative solutions to enhance efficiency and sustainability. The demand for the lightweight and durable construction materials has led to the development of advanced wall panels that offer compelling alternative to the traditional building components. Lightweight wall panels are engineered materials that offer reduced density compared to traditional buildings components, without compromising strength and durability. Lightweight wall panels offer a wide range of benefits such as ease of installation, reduced transportation costs, and improved thermal performance. The aim of this paper is to provide information about various types of wall panels and its advantages and disadvantages. The applications of lightweight panels span across residential, commercial, and industrial buildings. These panels contribute to energy efficiency by providing insulation and reducing the overall impact on the buildings.

Keywords: Lightweight wall panels, Expanded Polystyrene (EPS), foam concrete, composite materials, Reduced density.

INTRODUCTION

The development in construction field all over the world creates a huge demand for construction materials. The wall of the building constructed using masonry system or normal concrete contributes higher dead weight of the structure. Due to higher dead load the need for the larger size of the structural member's increases. So the reduction in the size of the wall reduces the need for the larger size of structural members and also contributes to overall capital reduction. To fulfill these reasons there is a need for an alternative system for wall construction.

Lightweight wall panels are the construction materials designed to be significantly lighter than traditional building systems. These panel typically consist of lightweight materials which contributes to their low density and exceptional strength to weight ratio. The lightweight nature of these panels leads to advantages such as ease of handling, transportation and installation, which further leads to decreased labor costs and also saves time.

TYPES OF LIGHT WEIGHT WALL PANELS

1. Foam concrete

Foam concrete is also known as cellular concrete, is a lightweight building material. Foam concrete has its roots in the early to mid-20-th century It is a type of concrete which contains small air bubbles of size between o.1mm to 1.0 mm diameter. There are various methods to incorporate air bubbles in concrete such as usage of chemical agents which creates air bubbles, foaming agents or vacuum curing. The most effective method to make foam concrete is the one that uses foaming agents. According to the American institute of concrete (ACI), A cellular lightweight concrete is a mixture of cement, water and foam. Foaming agents were introduced to the production process to create a stable foam. These agents can be either synthetic- based or protein- based. The main aim of the foam concrete is to reduce the density of the concrete and making it lighter.

Fig 1 Foam concrete panel

The production of stable foam concrete depends on the foaming agent used, production method and mix design. There are 2 types of production methods of foam concrete: mixing method, preformed foam method. In mixing method, the foaming agent id added to the mixer having higher rotating speed. in the performed foam method, the foaming agent and water is poured into a compressed air equipment which creates bubbles. These bubbles are added to the mortar to make it as cellular concrete.

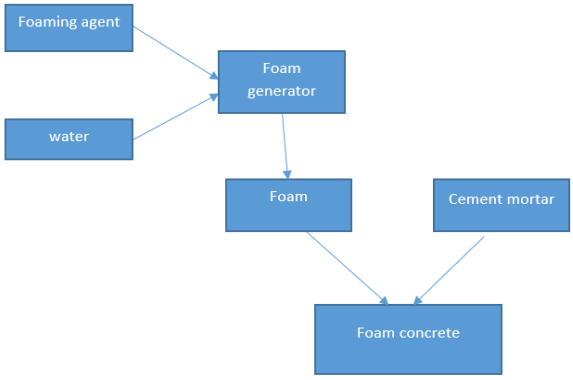

Fig 2 Manufacturing process of foam concrete

The performed foam used may be either dry or wet. The dry foam is stable compared to the wet foam as it creates bubbles with sizes below 1mm.The performed foam method is most efficient method for creating foam concrete and also very expensive compared to mixing method. The main advantage of using preformed foam method is it creates stable bubbles with low consumption of foaming agents. The density of the foam concrete varies from 300- 1600 kg/m³ whereas the density of the traditional concrete is 2400kg/m³. The compressive strength of the foam concrete at 28 days ranges from 0.2 – 10N/mm².

Advantages:

1. Foam concrete structure has excellent load spreading and distributing capability.
2. Cost effective.
3. Less maintenance.
4. Faster work completion.
5. Higher resistance to freezing and thawing
6. Acoustic insulation and thermal insulation

Disadvantages:

1. Time of mixing is longer
2. If the density of the foam concrete increases, the compressive strength decreases.

2. Expanded polystyrene (EPS) panel

Polystyrene is a synthetic polymer made from the monomer styrene which is derived from benzene and ethylene. Polystyrene is a by-product of petroleum. Polystyrene is a thermoplastic material and commonly used to make foam board or bead board insulation and a type of loose fill insulation consisting of small beads of polystyrene. The expanded polystyrene (EPS) beads are made from polystyrene beads that are fused together before being expanded. Expanded polystyrene is discovered by Edward Simon in 1839 in German by an accident. EPS consist of 95% of air and 5% of plastic.

The production of expanded polystyrene (EPS) panels involves several steps, from raw material to the final product. The raw material for EPS panel is polystyrene and blowing agent. Polystyrene mixed with blowing agent is exposed to steam by using pre-expander machine, where it is leads to the formation of small with a closed cell structure. The blowing agent vaporizes during this stage leads to expansion of the beads. These EPS beads are then moulded into blocks using moulds. During the process of moulding additional steam is

applied to the beads which causes further fusion of beads. The expanded EPS blocks are cooled to facilitate handling. After cooling, the EPS blocks are cut into desired panel size. The cut panels undergo additional shaping process such as grooving etc., The finished EPS panels undergo quality control checks to verify whether the panels meet the desired standards. This process includes checking for density, dimensions, structural integrity and other performances.

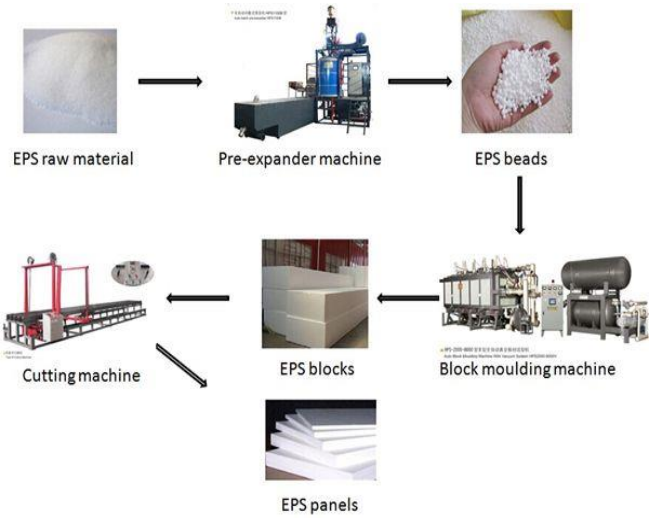

Fig 3 Manufacturing process of EPS panel

These EPS foam can be sandwiched between two metal surfaces. EPS foam in the middle provides insulation properties to the entire sandwich panel. In this type of sandwich panel, EPS foam surfaces are bonded to the metal plates using a specialized adhesive to ensure the bond is strong and durable. EPS foam can also be sandwiched between a galvanized steel wire mesh that is plastered on both sides with concrete. EPS wall panels are durable, strong as well as lightweight and can be used as an insulated panel system. EPS wall panel are used in the construction of interior and exterior bearing and non- bearing walls and floor of the building for all types of construction.

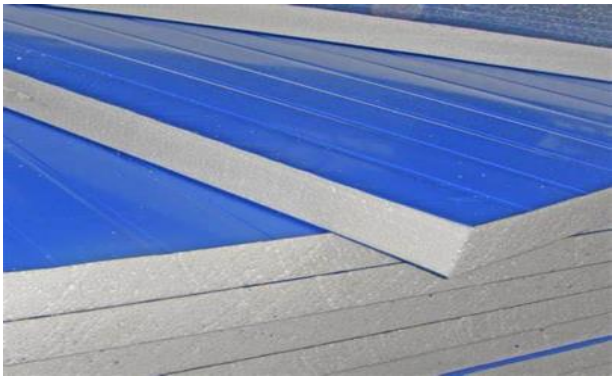

Fig 4 Sandwiched EPS panel

Advantages:

1. Decreases the construction period
2. Excellent thermal insulations
3. Fire resistance
4. Reduces energy consumption
5. Easy to install

Disadvantages:

1. EPS beads is flammable.
2. It has limited load- bearing capacity
3. Vulnerable to UV radiation
4. Required skilled installation

3. Autoclaved Aerated Concrete Panel (AAC Panel)

Autoclaved aerated concrete wall panel is a lightweight concrete building material invented in 1920s by a Swedish architect and inventor Dr. Johan Axel Eriksson. Autoclaved aerated concrete panel is made up of sand, cement, lime, aluminum powder and welded steel mesh.

Fig 5 Autoclaved Aerated Concrete Panel with reinforcing bar

Fig 6 construction process of AAC panels

The manufacturing process of AAc wall panels includes raw material perparation, grid mesh preparation, pouring, mesh inserting, cutting, autoclaving, packing and transportation etc., Welded steel reinforcement nesh is produced and processed by a special anti-rust liquid. Raw materials are mixed with water to form a slurry. This slurry is poured in the mould and the steel mesh is inserted into the mould. After curing process the autoclaves aerated concrete is cutted based on the desired specifications. This panels is sent into the autoclaves to get higher strength.then the panels are packed and transported.

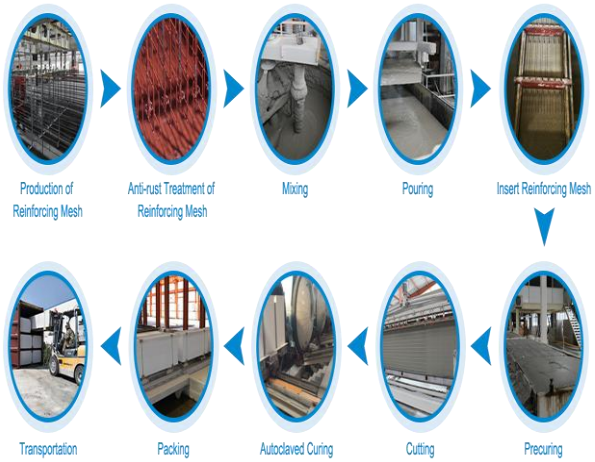

Fig 7 Manufacturing process of AAC panel

AAC panels can be used directly in interior and exterior wall of concrete structures and steel structures. AAC panels are thinnest and provides better sound insulation and fire protection. It is also used as roof panels and floor panels.

Advantages:

1. Adequate seismic performance.
2. Fire resistance
3. Eco-friendly
4. Durable
5. Resistance to pests
6. AAC can be moulded into various shapes
7. Acoustic insulation

Disadvantages:

1. Initial cost is higher compared to traditional building materials
2. Brittle material
3. Requires specialized installation techniques.
4. Limited load bearing capacity.

4. Structural Insulated Panel (SIP)

Structural insulated panel is a type of sandwich composite panel consisting of two layers of rigid materials as skin and a thick insulating layer as core. SIP was introduced at the Forest Product laboratory in Madison, Wisconsin in Unites States. There are variety of skin materials for SIP such as metal, fiber cement, cement, calcium silicate, gypsum and oriented strand board(OSB). The SIP's core insulating materials are polystyrene (PS), expanded polystyrene (EPS), or polyurethane (PUR); and its derivative, such as polyisocyanurate (PIR).

Fig 8 Structural Insulated panel

The manufacturing process of SIP has two techniques. In the first technique, an adhesive is used to bond the skin and inner core of the panel. After the application of the adhesive, the panels are kept under the presssure and heat until the adhesive is cured. In the second technique, foam core is used. A foam core is introduced between the two skin layers. The bonding is achieved by the setting of the foam.After the manufacturing of the SIP , the panels can be cut into the desired sizes. These panels are used as floor, wall, roof.

Advantages:

1. Minimal material wastage
2. Controlled quality
3. Quick construction
4. Thermal insulation
5. Resistant to warping, twisting.

Disadvantages:

1. Rodents and insects can nest inside the spaces od SIP.
2. Limited local availability
3. Sensitive to moisture
4. Expensive

CONCLUSION

In conclusion, lightweight wall panels offer a wide range of advantages and disadvantages compare to the traditional construction materials. For projects prioritizing speed and efficiency, lightweight wall panels can be a favorable choice due to their quick installation and potential for fabrication. The type of wall panel for the project should be decided based on the requirements, environmental conditions and budget considerations. The main advantages of these panels are energy efficiency, quick construction, strength and durability. The reduced construction waste and design flexibility are other additional advantages of the lightweight wall panels. There are some challenges due to issues such as initial costs, limited availability in certain regions, and concerns about long term durability and fire resistance must be carefully considered.

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