Descriptive Analysis of Advantages and Disadvantages of Expanded Polystyrene Monolytic Panels - EPS

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Abstract

The light concrete of expanded Polystyrene is an innovation in the construction market, as it stands out for its execution, cost and efficiency. This new technique seeks to provide the constructions: lightness, cost reduction, reduction of time in works and good thermal and acoustic performance, producing comfort to the environment. This work aimed to study the use of light EPS concrete (Styrofoam) in internal and external walls, presenting the comparisons between this system and conventional masonry with ceramic blocks through the monitoring of a work in the city of Manaus - Amazonas.

Keywords: EPS; Lightweight concrete; Constructive method;

1. Introduction

The construction system of panels in EPS was developed by Monolite, so called the Monolite system, contemplating important advances for civil construction, more specifically for masonry lift. The construction process can be used both as structural closure as well as sealing structure. In the analyzed works, not only were the use of panels, but also in a mixed system with reinforced concrete structures or metal structures.

Monolithic panel (also called Monolite or monolithic only) consists of a large expanded polystyrene plate (EPS), high-strength lightweight steel meshes interconnected by electrowelded steel bars and additional layers of mortar or concrete, put into work by traditional processes or designed using projection equipment. The origin of expanded polystyrene (EPS) panels comes from an Italian project, developed in a region subject to earthquakes, in order to create a monolithic structure that did not collapse and aggregate thermal insulation elements in the early 1980s (SOUZA, 2009).

According to Luebe (2004), expanded polystyrene has been used in Brazilian civil construction in a growing way, using expansion joints, lost coffin, insulation and road foundation, gaining space in the construction of slabs. It has been used in several countries around the world for more than 40 years, safely and efficiently, among all the technologies used in civil construction. Contrary to the thought, of being a premature system, the construction system with walls raised from panels produced in EPS and steel mesh, arrived in Brazil around the year 1990.

Polystyrene, or Styrofoam, as it is known in Brazil, is a synthetic aromatic polymer made with the styrene monomer, a liquid derived from the petrochemical industry, can be rigid or foamed, usually used in its white, hard and brittle shape. Taking into account its weight, it is a cheap resin, being widely used as an efficient barrier against oxygen and water vapor, having a relatively low melting point (AVESANI NETO, 2008).

These are structured with low carbon steel screens, with galvanized wires of 2.1 mm in diameter and mesh 50 x 50 mm or 150 x 50 mm, positioned, on its two sides. The plates are interconnected with each other, by galvanized carbon medium steel connectors, with 2.76 mm in diameter, electrosoldiers to the screens, forming a truss. Subsequently, in the construction process, receiving, on each of its faces, a layer of fck microconcrete = 25 MPa with a minimum thickness of 3.5 cm (TECHNE, 2012).

The dimensions of the panels are changeable, according to the desired modulation of the architectural design. Compared to conventional systems, there is a considerable reduction in waste and requiring reduced labor for the assembly of panels. There is a decrease in the manufacturing process and in its assembly, as it can reduce the costs of the foundation when using these panels, since they are lighter materials than another type of seal (SOUZA, 2009).

In order to understand aspects of safety, habitability and sustainability, it is an important thing to talk about materials that make up the system, which are summarized in expanded polystyrene (EPS), galvanized steel and concrete.

From this and knowing that housing is the most desired construction one should understand and evaluate the constructive process in EPS panels in order to understand the complete system and its benefits.
Thus, we sought to evaluate and characterize the construction process in EPS panels, its system and benefits.

2. Methodology

A case study was carried out, characterized by a deep analysis of objects, which allow broad knowledge and other types of designs considered (GIL, 2007).

This research is of qualitative characteristic, a systematic procedure with the objective of providing answers to the proposed problems. Research develops from the formulation of the problem to the presentation and discussion of the results (GIL, 2007).
The study deals with the analysis of the advantages and disadvantages of the use of expanded polystyrene monolithic panels (EPS) in the construction process of popular houses, aiming to demonstrate the cost in relation to the use of this process.

3. Results and Discussion

The construction system is characterized by an alternative for replacing materials such as conventional masonry. Thus, we sought to understand the advantages of EPS in relation to the conventional.

Table 1 - COMPARISON BETWEEN CONVENTIONAL MASONRY METHOD AND EPS PANEL

CHARACTERISTICS	CONVENTIONAL MASONRY	EPS PANELS
MECHANICAL RESISTANCE	Excellent mechanical strength, however, lower than the system in EPS panels. It drives more heat, but spends more energy	Low thermal conductivity, reduction of energy and air conditioning expenses
FIRE RESISTANCE	Excellent. For a wall with a 9 cm block and mortar of 6 cm thick, one has a time of 150 min	Low. For a wall with 9 cm thick panel and 6 cm thick mortar one has a time 40 min. Flame retardation
THERMAL INSULATION K (W/m.k) thermal transmission coefficient (CCT)	It is constituted by good insulation, but the ceramic block has a lower resistive capacity than the EPS. Its coefficient ranges from 0.9 to 1.2	Main features, high ability to resist heat passage, its cell structure closed. Its coefficient ranges from 0.035 to 0.042
SOUNDPROOFING. Rw (db) sound resistance	For a wall of 15 cm (9 tij. + 6 arg.) you get a Rw=38 db	For a wall of 14 cm (8 EPS + 6 arg.) you get a Rw=38 db
STORAGE	Its storage takes up a lot of space, reducing the mobility rate in the work	It can be stacked horizontally superimposed with a maximum of 20 panels. Reduces space occupancy
WEIGHT	Larger, so that in the same dimensions that the panel with a thickness of 15 cm can reach 250kg/m²	Reduces the structural weight of the work, as the EPS is 98% composed of air. The finished panel with 15 cm thickness has its weight around

		120kg/m²
MANPOWER	Does not need a specialized workforce	For its simplicity of execution does not require specialized labor, but a qualification through training
SPEED OF APPLICATION (PRODUCTIVITY)	Because of its fully artisanal system, it is characterized by a much slower and less productive method	Due to the easy handling and simplified application characterized by modularity, it presents high executive productivity
PRICE	Low initial unit cost, due to the abundance of its materials and simple manufacture	Higher initial unit cost, however, if taking into account the entire context involved the price may become lower
DURABILITY	Larger than any other material, being can exceed 100 years	The age limits of the EPS are not known, but understands that the material has great durability, as it keeps its properties unbeaten over the years.
EXECUTION OF COMPLEMENTARY INSTALLATIONS	Less efficient due to the need for rework to perform	Facilitated due to no need for cutouts of the walls
WASTED MATERIAL	Because it is a totally handmade concept, where the executive process is totally geared towards an almost always disqualified workforce, to a huge waste rate in this system	Due to their modular character, where the parts already come ready according to dimensional needs, it is possible that there is a reduction of almost 100% in waste
PLASTER ADHESION	Its adhesion capacity is much higher, due to a greater porosity that the material presents	There is difficulty in joining this material, due to its very high impermeability
MARKET	There is a better acceptance by its users	Limited due to factors such as ignorance of the material regarding its advantages
PAVEMENT LIMITATION	There are no limitations and can be checked in the most diverse quantities	There is a limitation of up to 4 floors. Since to obtain larger numbers, it is necessary to resort to auxiliary structures such as beams and pillars
SUSTAINABILITY	Large amounts of debris are used for further dumping, using a lot of water and energy from its manufacture to execution.	Expanded polystyrene 100% recyclable and reusable. With its use decreases the consumption of water and energy from its manufacture to its execution and decreases the generation of waste to nature.

Source: Own Authorship.

The EPS construction system presents numerous phases, where initially the foundations are prepared, made,

according to the structural calculation, depending on the type of land, which can be adopted different types of foundation: type radier slab (with 18 cm of height); wall footing (40 cm wide and 15 cm deep in simple designs); or a special foundation, if, the terrain or architectural polling conditions are not favourable to the (TECHNE, 2012).

For hydrosanitary, electrical, communication, safety and others that may interfere with the radier, they are positioned before the foundation begins. The pipe is grounded and leveled where on the ground there is the launch of the counter floor concrete. Once this initial part is done, one must proceed to the base of the floor, so that they are developed, with more cleaning and efficiency (Figure 1).

Figure 01: Radier type foundation
Source: Monolite, 2017.

After the foundation is concreted, the process begins in which the assembly of the base, alignment and plumb of the panels, for the lifting of walls, the assembler must fix the panels at the previously placed starts with the aid of a stapler, with AC steel clamps 60 (the same as attaching the mesh to the panels) or simply with annealed wire and tools. The panels have overlapping steel mesh flaps, so that they are sothey are sodoted to the next panel.

The assembly of the panels takes place in a simple and manual way, being connected to each other and to the starts with the use of annealed wire and pliers or through the use of a pneumatic pistol (stapler) (BERTOLDI, 2007) (Figure 2).

Figure 02: Stapler for Mooring of Panels in The Starts
Source: Thermotech, 2014.

The assembly of self-supporting panels is not complex, but requires care and standards to avoid misunderstandings in construction. They must be aligned with the iron guides of the contra piso and mounted on the plumb, where the fixation is made by clamps and annealed wires. The panels will be numbered by the manufacturer of the construction system and the mesh tabs of each panel must overlap the tabs of the next panel for composition of the monolithic assembly (Figure 3).

Figure 03: Panel fixed on the start-ups of the radier type foundation
Source: ISOMAF (2019).

After the panels are installed, you can embed the electrical, hydraulic and sanitary pipes. The execution of the facilities takes place in a practical and fast way, without the production of debris and need for rework, keeping the built environment clean.

This is one of the advantages of this system compared to conventional masonry, in which according to Lueble (2004), in the placement stage of pipelines and pipes, a conventional construction, presents a high waste of materials, because masonry is broken and generated debris, which must be collected from a recycling plant (Figure 4).

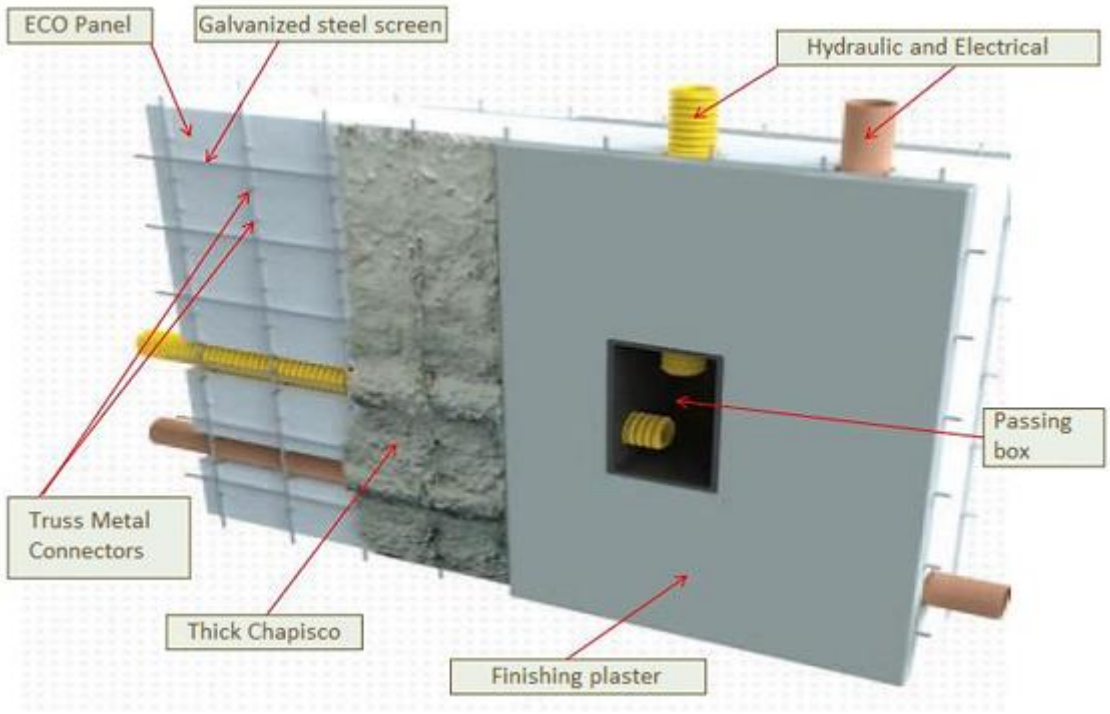

Figure 04: Electrical and hydraulic installations
Source: MONOFORTE, 2016.

In the case of rigid or semi-rigid tubes, when necessary, the metal screen is cut with pliers and at the end, the screen is closed again to hold the pipe. The system admits sophisticated mesh grounding, creating a Faraday cage and for multi-floor designs, recommending the use of shafts, as it facilitates access to and maintenance of electrical and hydraulic systems.

After the assembly of the panels, with alignment and plumb checked and all hydraulic and electrical installation has been carried out, the coating with mortar must be performed, which can be applied by manual process or by means of a pneumatic projection, with predetermined thicknesses according to the project. The use of pneumatic equipment provides greater productivity, coating compaction quality and causes low vibration to panels when compared to the manual process.

The coating is applied in two layers, the first has the function of filling the surface of the EPS until facing the mesh of the steel screens. The coating should always be done on both sides of the panel, so that it is not only one of the coated faces for healing, preventing the system from presenting differential retraction (MACHADO; PINTO, 2001) (figure 5).

Figure 05: Application of microcement with equipment
Source: Téchne, 2012

Only after application and curing the mortar, which the panel has resistance and becomes self-supporting, and can be used as a sealing element or also as a structural element of high load capacity. From the union of steel meshes and mortar micropillars are formed along the wall, which results in a monolithic building that resists earthquakes (seismic events) and vertical loadings.
In the application of the finishes there is nothing different from the others, it will be carried out in the same way as a conventional system, such as the application of tiles, plaster or mass running (SILVA, 2009) (figure 06).

Figure 06: Final Finish
Source: Téchne, 2012

Among the various advantages and benefits that the use of this construction system with monolithic panels in EPS can provide, we can mention the following:

- Low thermal conductivity: in which its organization is formed of numerous closed cells, with very small diameter, full of air, with the blocking of heat passage. A foundation that indicates the excellent thermal insulation capacity of the EPS is its constitution (98% air and 2% polystyrene), leaving, due to the amount of air, inside the cells without locomotion. Thermal insulation capacity is demonstrated by the Thermal Conductivity Coefficient (TCC), which, the lower the coefficient of thermal insulation capacity (REIS, 2015);
- Baixo peso: as execuções realizadas na obra são significativamente reduzidas, devido ao seu baixo

peso, facilitando os serviços e podendo reduzir prazos (REIS, 2015);

- Low thermal conductivity: explained by closed cells and large amounts of air, which end up hindering the passage of heat. Thus, demonstrating itself as a good insulator (COSTA, 2007);
- Mechanical Resistance: even though it has a low weight, it has a high mechanical strength, which can be applied when this attribute is necessary (REIS, 2015);
- Construction up to 40% faster when compared to conventional masonry;
- The EPS used in the works does not generate combustion: characterizing safety for any work;

It is essential to have a high quality material, which is certified and produced by specialized companies. The EPS used in the walls is differentiated and come in panels ready to be fixed on the base, so one should always buy from a renowned manufacturer so as not to have problems in his work with some disadvantages, such as consumer ignorance; low adhesion to the chapisco; high initial cost.

4. Final Considerations

Depending on market changes and current trends where the focus on sustainable construction swells is growing significantly, the use of methods that reduce waste creation and energy expenditures, becoming increasingly frequent in construction occupying more and more space, showing that the monolithic system of EPS is an advantageous option for those looking for innovative constructions.

It was observed that the method of monolithic polystyrene panels (EPS), is a new and innovative system in Brazil, replaces conventional walls, because it is a prefabricated, modular, lightweight system composed of expanded polystyrene EPS, enabling a new and advanced construction system, by synthesizing the advantages of the traditional system and prefabricated, dispensing beams and pillars, and towed in structural mortar.

Light concrete is recognized for its reduced specific weight and high thermal and acoustic insulation capacity. As it is a product of fast production and application, high fluidity (molded without needing density), presents itself as an excellent option for execution of structural walls or sealing.

The use of EPS plates for the elevation of internal walls is an economically and technically accessible solution, given the speed and containment of expenses provided to the construction of the work under study. Thus, the greater the size of the work, the more advantageous the system becomes.

It is concluded, then, that this system is economically viable to build popular housing, because its thermal, acoustic and sustainable advantages characteristic of the method. EPS panels have become a sustainable solution reducing the use of renewable materials, this method does not generate leftovers, as all parts are designed and manufactured on measures, through architectural designs the panels are delivered to be delivered to be fixed in the work, thus minimizes the loss of materials at the time of execution.

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