MONOLITHIC PANELS OF EPS-REINFORCED MORTAR: DESCRIPTION OF THE CONSTRUCTION SYSTEM AND CASE STUDIES

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ABSTRACT

This article aims to present the construction system of monolithic panels of reinforced mortar with expanded polystyrene (EPS), addressing the construction method, the benefits to the environment and the applications of the system through case studies. The research presents a literature review on the history and components of the monolithic panel system, highlighting its characteristics and advantages in the construction context. For the case studies, technical visits were carried out in constructions in the municipalities of Votuporanga and São José do Rio Preto, São Paulo, supported by local builders. From the literature review and the visits made, it is concluded that the use of monolithic EPS panels shows promise for innovations in the field of engineering, due to its versatility and benefits to the environment and the consumer, making this an alternative system to conventional masonry.

Keywords: Monolithic panel. Reinforced mortar. EPS. Case studies.

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INTRODUCTION

Nowadays, the great advancement of technologies in the civil construction industries is notorious, bringing innovative construction methods for the benefit of future customers. New ways to have thermal and acoustic comfort in the construction of a residence are discussed, seeking a solution that brings a favorable result to the client and the environment.

The construction system composed of EPS walls, steel and mortar becomes a solution that favorably meets climatic conditions and benefits the environment, since it uses Styrofoam as an insulating material to fill the panels, something innovative today, in addition to resulting in a clean construction, without the formation of much waste.

According to Bertoldi (2007), in the mid-80s, a construction system composed of expanded polystyrene panels, reinforced by steel screens and covered by mortar or concrete, was called the *Monolite System*. This system was developed due to the increasing demands of the inhabitants, especially about the quality of environments.

The method uses Expanded Polystyrene plates inside, plus electro welded steel screens on the sides and later coated with mortar. The introduction of this method in Brazil only arrived in the 90s, however, today, more than 30 years later, it is still little used (Paula and Teixeira, 2019, *apud* Neves, 2023).

Its main characteristic is sustainability, since civil construction is a major generator of waste that triggers environmental and social problems. It can be used not only as a sealing system, but as a structural element, presenting great advantages when compared to commonly used methods, such as conventional masonry of ceramic blocks and the *drywall* system, of which we can mention: speed in construction, low cost of execution and labor, good thermal and acoustic characteristics, lower self-weight and greater resistance and practicality related to the installation of hydraulic and electrical building systems (Affonso, *et al.*, 2023).

Although the method is still little used, there has been a growing use of monolithic EPS panels in civil construction due to the low cost, thermal and acoustic insulation and sustainability. Such aspects have stood out as advantages when compared to the conventional masonry system (Lima and Negrini, 2024).

LITERATURE REVIEW

The Brazilian economy has civil construction as one of its pillars and when the sector is on the rise, both services related to construction and the trade of materials generate a great virtuous cycle of job and income generation, according to information obtained from the CBIC website (Brazilian Chamber of the Construction Industry, 2023).

The traditional construction system, which uses reinforced concrete structures and masonry closure, continues to be the most used in Brazil. This is due to its popularity and familiarity among construction professionals (Vasques, 2014).

According to national real estate indicators, made available by CBIC for the 3rd quarter of 2023, there is a continuous increase in residential units. With this increase, the demand for construction methods that can save time and money becomes an attraction for this market.

According to Gasparini et al. (2021), one of the market alternatives is the construction of molded walls on site, formed by EPS (expanded polystyrene) panels with mortar, microconcrete or concrete sprayed on the EPS panel.

DEFINITION

Guideline No. 11 of the National System of Technical Evaluations (SINAT) defines this construction system as walls, molded on site, consisting of components of expanded polystyrene (EPS), steel and mortar, microconcrete or concrete. The system has been used as an alternative construction to conventional masonry, serving as structural panels (performing the function of beams and columns) or sealing (non-structural walls or slabs) (Medeiros, 2017).

Also according to Medeiros (2017), this method is basically made up of internal panels, forming the core, of insulating material (EPS), armed with welded meshes, arranged on each of the microconcrete faces and interconnected using welded bars, in a three-dimensional configuration, which generates good rigidity.

HISTORY

Originally, the construction system of EPS, steel and mortar walls, appeared in the early 80s in Italy, where it was called *Monolite*, which was an old Italian company. This search for innovation was due to climatic conditions and seismic shocks, which is very common in the region. Subsequently, this system expanded to most European countries (Alves, 2015).

In Brazil, the construction system in question arrived around the 90s, but its use was limited only to people who worked with it. Given this, it was up to large companies to implement the *Hitech* system (Bertoldi, 2007). From there, it was made official as an alternative construction system.

According to data from the Civil Construction Industry Union of the State of São Paulo (SindusCon-SP), this construction system is already used in about 10% of civil construction works in the country. This number tends to grow in the coming years, as the technique shows numerous advantages over the traditional method (SEBRAE, 2023). Figures 1 and 2 show some constructions that were made using this construction method.

Figure 1 Example of construction using the EPS construction system

Source: Balbino (2017).

Figure 2 Example of construction using the EPS construction system in Varginha/MG

Source: Costa (2020).

According to Casas [202-], in Kenya, the construction system composed of EPS, steel and mortar walls (Figure 3) is presented as an advantage because of the reduction in the total cost of the work and its technical qualities. In addition, the system won over the country's state-owned housing corporation, the *National Housing Corporation* (NHC), where about 50 houses were built in Nairobi and a 5-story building with 20 apartments in *Ole Kasasi*.

Figure 3 Example of construction using the EPS construction system in Kenya

Source: Kiptum *et al.* (2020).

Another favorable aspect of using EPS as a construction system is in the manufacture of ICF parts, which are widely used in civil construction. The ICF emerged in the 60s in Canada, where the German Werner Gregori produced the first ICF (*Insulated Concrete Form*) formwork. He noticed that children built sandcastles on the beach and Canadians used Styrofoam boxes to keep drinks cold, since his job was as a builder, he began to have ideas on how to use Styrofoam in civil construction as a formwork, which would be filled with concrete (Ribeiro *et al.* 2022).

Also according to Ribeiro *et al.* (2022), after one year, the first ICF formwork was officially developed and patented on March 22, 1966 in Canada and on October 24, 1968 in the United States. The formwork consisted of a medium prototype of 0.40 m long and 1.20 m high that had a tongue and groove, whose faces were tied with metal and on the inner and outer sides with steel mesh. After this prototype became known, Werner Gregori returned to Germany to meet the company BASF, a chemical company that invented EPS, to combine his ideas with the invented prototype. As his idea was not patented in Europe, the scientist Karl Holik used EPS together with Portland Cement to create, in 1971, the composite ICF. With this technology advancing in the market, the company *Argisol* in Switzerland developed a wall formwork and, over the years, the formwork has been modernized and gaining space in the field of Civil Construction around the world, there are examples of constructions made with these formwork in Figures 4 and 5.

Figure 4 Construction using the ICF system

Source: ICFA (2010), *apud* Ribeiro *et al.* (2022).

Figure 5 Construction using the ICF system carried out in the Northeast of Brazil

Source: ICFFORTALEZA (2021), *apud* Ribeiro *et al.* (2022).

COMPOSITION

According to Araújo and Gomes (2022), expanded polystyrene (EPS), as defined in the DIN ISO-1043/78 standard, is a form of rigid thermoplastic foam, being internationally recognized. Its origin dates back to 1949, when chemists Fritz Stastny and Karl Buchholz made their discovery in Germany. This material is produced by polymerizing styrene in water, resulting in small spheres.

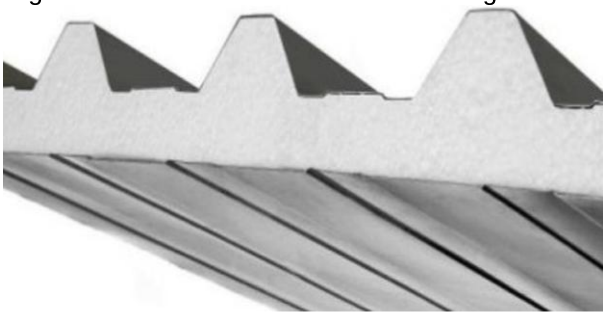
Also according to Araújo and Gomes (2022), during the manufacturing process, these spheres are expanded up to 50 times their original size, using steam, allowing them to be shaped into different shapes. After expansion, these spheres contain up to 98% air and only 2% polystyrene, making them a lightweight material. In addition, expanded polystyrene products are characterized by being odorless, non-polluting to the soil, water and air, being fully recyclable and reusable as raw material.

According to ABRAPEX (Brazilian Association of Expanded Polystyrene, 2006), its properties include low thermal conductivity, lightness in the structure, mechanical resistance, low water absorption, ease of handling, versatility, durability, impact absorption capacity and resistance to compression, which are characteristics sought by civil construction.

Because of its versatility, EPS can be molded into specific shapes or blocks of standardized sizes for later cuts. It can also be used, due to its practicality, in thermal insulation, protection in the transport of materials, in helmets and in PPE (Sousa, 2021).

Currently, in the civil construction sector, this material can be used as slab filling, manufacture of sandwich tiles (Figure 6) and aggregate in lightweight concrete (Figure 7) (Tessari, 2006).

Figure 6 Steel tiles with EPS as insulating material



Source: Tamiosso (2017, p. 58).

Figure 7 Lightweight concrete made with EPS beads

Source: Xavier (2015).

In addition to EPS, the system makes use of reinforced mortar. According to Medeiros (2017), reinforced mortar together with welded mesh are responsible for ensuring the strength of the monolithic system. The reinforced mortar system was patented in France, being considered the precursor of reinforced concrete.

According to Campos (1994), reinforced mortar can be defined as a reinforced microconcrete, resulting from the association of mortar with a steel mesh consisting of wires of small diameter and little spaced from each other, like a welded mesh.

According to Costa (2020), for the application of mortar, the surface of the panel must be clean, without substances that can reduce adhesion with the panel. For the author, the common composition of the mortar trace is 1:3 (cement and sand by volume), requiring 200 ml of plasticizer additive and 200 g of polypropylene microfiber (6 mm) per bag of cement. The author explains that the application of the mortar must be done in two layers, the first up to the height of the steel mesh, and the second with 2 cm of covering. The second layer should be performed within a maximum of 48 hours after the application of the first layer.

Bertoldi (2007) explains that the plasticizer additive is necessary to avoid low workability due to the low water consumption of the mixture, since the microfibers have the purpose of increasing the toughness of the mortar and forming an anti-shrinkage mesh. The author also comments that the material when applied cannot run on the panel and must have an adequate consistency.

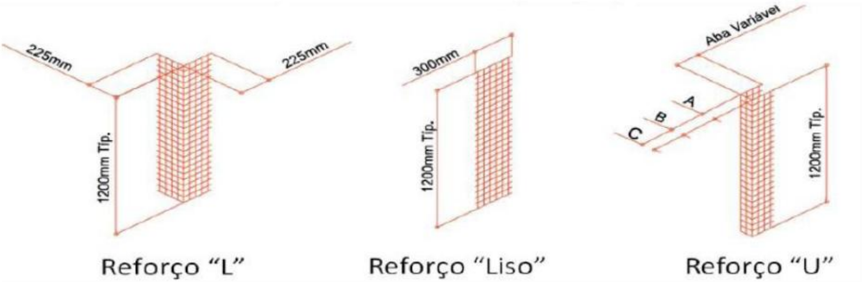
According to Alves (2015), mortar should be applied on both sides of the panel concomitantly, to avoid differential shrinkage on the coated faces. Figure 8 shows the projection of reinforced mortar using a mechanizing system, which is widely used by this construction system.

Figure 8 Projection of the mortar on the panel

Source: Alves (2015).

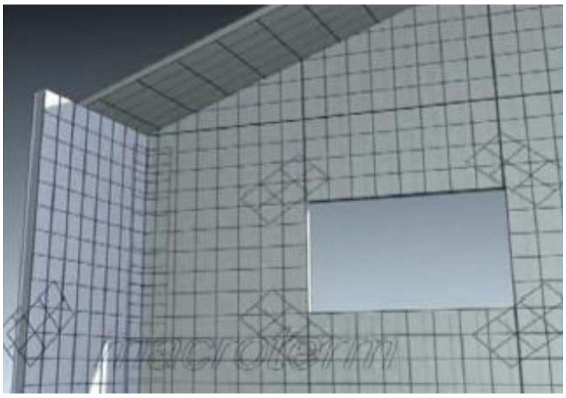
The meshes are produced with high strength steel (AR), being superior to CA-60, with gauges ranging from 2 mm to 10 mm, containing a spacing between 5 cm x 5 cm up to 30 cm x 30 cm, varying with the need of the project. In the current market, knitted fabrics in the "L", "U" or "smooth" shapes are found (Bertoldi, 2007), as shown in Figures 9 and 10.

Figure 9 Types of reinforcements



Source: Alves (2015, p.15).

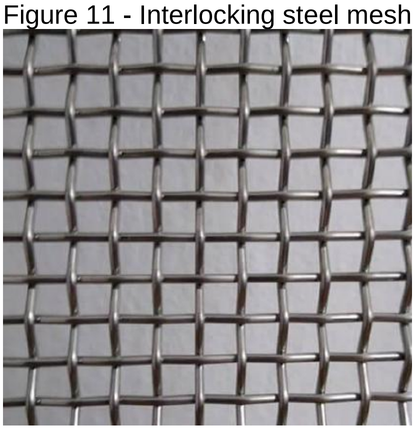
Figure 10 Use of reinforcements in the corners of the walls and the window



Source: Alves (2015, p.16).

According to Musse (2017), the interlaced square mesh steel mesh, as represented in Figure 11, has good malleability and can adapt to complex parts, but they are less efficient in controlling cracks due to the greater deformability of the interlaced wires.

Figure 11 - Interlocking steel mesh



Source: Tectelas ([202-?]).

Welded screens have a similar deformation modulus to wires, providing efficient crack control, as opposed to other screens that are more plastic. The arrangement of the wires at right angles helps them to be constructively placed on the main axes of forces, leading to better structural behavior (Chamelete, 1991, apud Chamelete 1999).

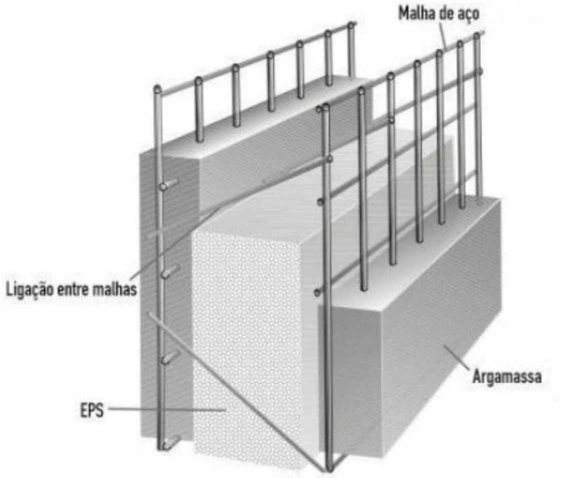
CONSTRUCTION FEATURES

Novais et al. (2014) compared temperatures in a residence in Cuiabá-MT, where one room was built in conventional masonry and another with monolithic EPS panels. The study concluded that the room with monolithic EPS panels showed an average temperature reduction of 4.63 °C compared to conventional masonry, with a maximum difference of up to 7 °C.

The panels demonstrate great flexibility and integration with construction systems. This characteristic is due to the dimensional variation of the screens, whether the thickness of their wires or the spacing between them, along with the variation of the EPS, such as density, thickness and length. Thus, they can be used for all structural elements (Bertoldi, 2007).

Also according to Bertoldi (2007), the expanded polystyrene (EPS) used in the production of the panel is located in the center of the panel and is responsible for the shape of the structure. The electro-welded steel meshes provide the structural function and are joined by bonds, which are located on the faces of the expanded polystyrene sheet. Figure 12 exemplifies the constituent parts of the system.

Figure 12 Representation of the inside of the panel in EPS



Source: Silveira (2018), *apud* Paula and Araújo (2022, p.2).

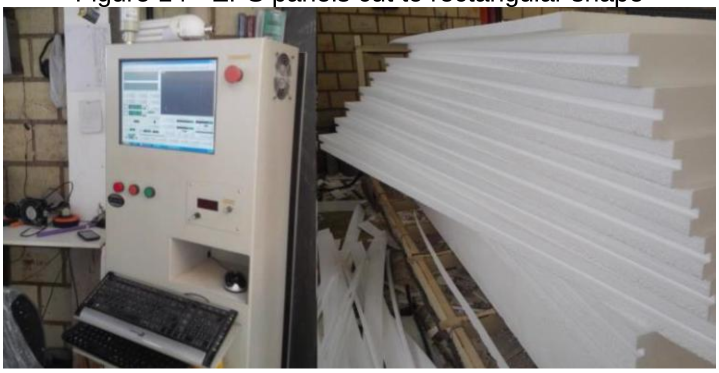
Nogueira (2022) mentions that, firstly, for the manufacture of the panels, the core is produced from polystyrene blocks made with the required properties. The cuts are made with the help of pantographs, which are programmable cutters used in block cutting, as shown in Figure 13.

Figure 13 Commercial pantograph

Source: Alves (2015).

The thickness of the EPS cut varies according to the project requirements and the expanded polystyrene core used in the construction system is standardized in a rectangular format, as illustrated in Figure 14.

Figure 14 - EPS panels cut to rectangular shape



Source: Alves (2015).

According to Duarte (2015), the monolithic panel system in EPS, as it is a lighter structure, will bring savings in the reinforcement of the foundations. It is assumed that the transmission of loads occurs uniformly to the foundation, as it is a system consisting of panels.

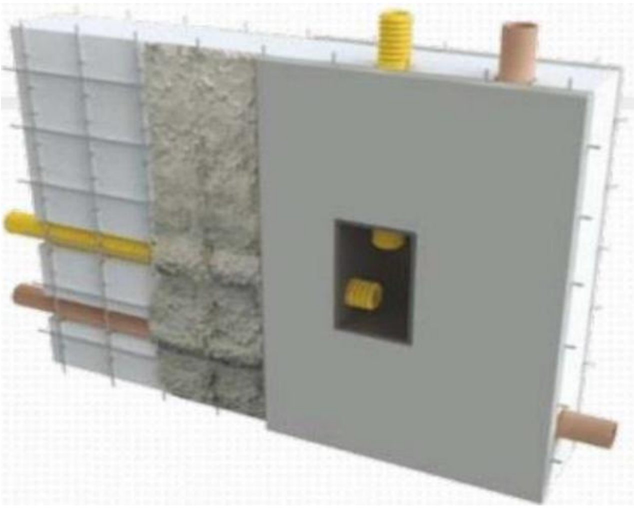
According to Nogueira (2022), the most suitable foundation for this system is the radier type, which consists of concrete slabs that are in direct contact with the ground. In the execution of the foundation, the steel starts are positioned for the subsequent fixation of the panels, as detailed in Figure 15.

Figure 15 – Starts on the radier for fixing the panels

Source: Alves (2015).

For the process of hydraulic and electrical installations, Alves (2015) explains that using a heat blower, the EPS is melted along the necessary path for the pipes and conduits. The pipes are positioned between the steel meshes, as illustrated in Figure 16.

Figure 16 Schematization of the execution of home installations in the panels



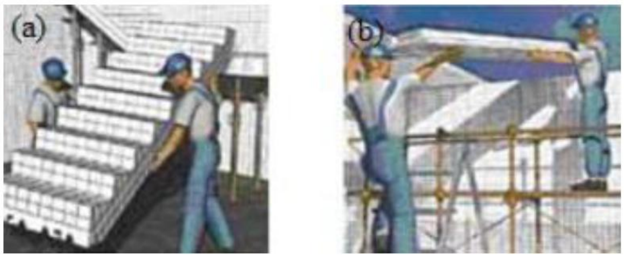
Source: Termotécnica (2015) *apud* Alves (2015, p.19)

Other types of applications of this system are in staircases, where the steps and mirrors are made of EPS and tied to the steel mesh, it is also applied in slabs where it replaces the standard masonry tile with EPS, as shown in Figures 17 and 18.

Figure 17 - Assembly of the staircase in EPS

Source: The author himself (2025).

Figure 18 – Assembly of the staircase (left) and the slab (right)



Source: Bertoldi (2007).

ADVANTAGES AND DISADVANTAGES

One of the main benefits of the construction system composed of EPS, steel and mortar walls is the speed in the execution of the work. As the panels are prefabricated, the assembly time is reduced by up to 50% compared to the conventional method. In addition, the low weight of the panels facilitates transport, handling and cutting, which makes installation even more agile (SEBRAE, 2023).

Another important advantage of the construction system studied is the cost savings. As the technique reduces the execution time of the work, there is a significant saving in relation to labor. In addition, the material is cheaper than conventional brick, which also contributes to the reduction of total costs (SEBRAE, 2023).

The construction system also brings sustainability as an advantage. Because it is a recyclable material with low environmental impact, the technique is considered more sustainable than traditional methods. In addition, the use of EPS contributes to the reduction of electricity consumption, since the material works as a thermal insulator, reducing the need for air conditioning or heaters (SEBRAE, 2023).

The use of this construction system considerably reduces the amount of waste compared to conventional masonry. The reduction in waste is easy to see, since conventional masonry discards about 30% of materials in the execution phase. In addition, of all the world's waste, 50% comes from civil construction (Pavesi, 2016, apud Kovac., 2023 p.18).

The generation of waste from this construction system takes place by cutting and installing monolithic plates, which are inferior to the waste generated by conventional masonry. The cuts are made in the production of staircases and the opening of frames, whose waste must be properly recycled, avoiding contamination of the environment (Trevejo, 2018, apud Kovac., 2023 p.19).

In addition, the monolithic system behaves in an impermeable way, since the humidity of the wall outside the panel does not have contact with the internal wall of the panel, as the external mortar does not have contact with the internal mortar, considering the monolithic system as beneficial in thermoacoustic and impermeable terms (Terencio, 2019, apud Kovac, 2023, p.18).

Regarding the disadvantages of building with EPS, it can be mentioned that it is not a recommended material for some establishments with a higher risk of fire, there is a requirement for specialized labor and maintenance and there is the difficulty of financing for the execution of the work, although there are already banks that are accepting financing (Casa Teto, 2020, apud Paula and Araújo, 2022 p.27).

Duarte (2015) says that labor is a disadvantage due to the shortage of qualified professionals, since this construction process is still becoming popular.

According to Alves (2015), another disadvantage of the system is the construction limitation, as it allows it to be used in buildings with a maximum of 5 floors.

According to Genol (2021), another disadvantage of the system is the difficulty of new openings in the wall that has already been completed, since the walls have a structural function, causing the construction to have restrictions on major design changes.

DESIGN CRITERIA

For the design of the panels, the Structural Design Method known as the Limit States Method is used. The Limit States Method for the design of structural elements is currently considered the most recommended by steel, wood, and concrete structure design standards (Nogueira, 2022).

It is used for the design of the panels, the usual theory of reinforced concrete of the Ultimate Limit State (ULE), using ABNT NBR 6118:2023 (Nogueira, 2022).

The sandwich structure consists of two resistant faces interspersed with a material (core), which is generally of low density and less resistant than the faces. The core is responsible both for keeping the resistant plates in the correct position, and for transferring forces from one plate to another (Bertini, 2022, apud Nogueira., 2022 p. 52).

Also according to Nogueira (2022), as with other construction systems, from the architectural project, the modulation of the reinforced walls is carried out. The initial design considerations are analyzed, such as the actions that act on the structure, the design methodology, the detailing of the structure, characteristics related to the materials used and the efforts considered in the calculation of the structure.

CASE STUDIES

At first, we tried to visit buildings that use this construction system in the municipality of Votuporanga, São Paulo. The search became favorable due to the support of a local builder, who provided the photographic records, in addition to granting access to visit his works.

Figure 17 is the construction of an upper-class residence located in a gated community in Votuporanga. It was observed that in this phase the construction would go through the stage of coating with mortar, therefore, the support of the panels using the props is essential so that it does not lose the leveling of the structure, impairing the final aesthetics and resistance.

Figure 17 EPS construction in the shoring stage

Source: The author himself (2025).

In this work, in addition to the plumb lines, metal stringers (left) and steel rebar (right) were used, as illustrated in Figure 18, in order to ensure horizontal alignment between the panels, due to their lightness.

Figure 18 \u2012 Use of metal stringers (left) and steel rebar (right) for horizontal alignment of EPS panels

Source: The author himself (2025).

The building visited in the municipality of São José do Rio Preto, São Paulo, was a commercial townhouse, in which the lower floor corresponds to rooms for law and the upper floor to the client's residence.

At first, photographic records of the construction of the lower floor were obtained, in which the stages of making the radier, demarcation of the walls in the radier, fixing of the panels at the starts, passage of the cold water, sewage and electrical pipes, in addition to the reinforcement of the corners of the walls and openings of doors and windows were recorded.

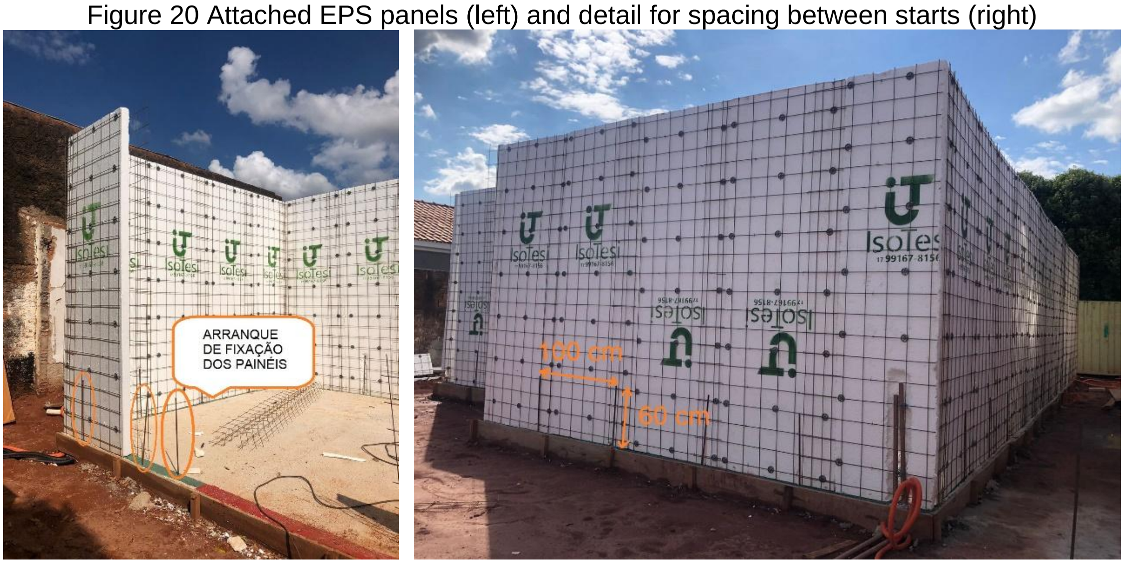
In Figure 19 it is possible to observe the 20 cm radier, which had already been concreted at the time of the visit, and the demarcations with green and red paint. Painting is used with the intention of facilitating and speeding up the execution of the work, since it avoids the constant consultation of the architectural project. The green color symbolizes that in that place there must be the fixing of the panel and the red that there will be a door or an opening for passage.

Figure 19 – Radier already concreted and color marking

Source: The author himself (2025).

Figure 20 shows the support starts of the feet of the panels, which are connected to the foundation frame, in addition, the two colors painted at the base of the panels are evident. In this work, the starters, 60 cm high, were arranged 50 cm apart from each other (the external with the internal), in addition, they were interspersed between the inside and the outside of the wall, in order to facilitate the fitting and fixing of the panel, since on opposite sides the lashing is more efficient and resistant.

Figure 20 Attached EPS panels (left) and detail for spacing between starts (right)



Source: The author himself (2025).

Figure 21 shows an important versatility of the EPS panel in the opening of frames, the steel mesh is sawn and then the EPS panel is cut into the required opening format. In this work, T2F Styrofoam panels were used on the lower floor, with a 4.2 mm mesh with 15x15cm sections, and T1F with a 3.4 mm mesh on the upper floor, also with 15x15cm sections, with type 1 referring to the minimum apparent density of Styrofoam of 9 kg/m³, type 2 with 11 kg/m³ and the acronym "F" means that it is flame resistant. A more resistant steel mesh can be observed in the lower panels due to the load of the upper floor.

Figure 21 Opening frames in the EPS panel

Source: The author himself (2025).

Figure 22 highlights the use of plumb bob during the installation of the panels, which is extremely important to ensure the quality of the plaster and avoid unnecessary mortar expenditure.

Figure 22 Use of the plumb bob for leveling the EPS panel

Source: The author himself (2025).

Another important point studied is the extension of the steel mesh of the panel, both on one side and the other, as shown in Figure 23. This extension is based on the connection of one panel with the other, ensuring the monolithicity of the set.

Figure 23 Extension of the steel mesh (left) and highlight for the connection of the panels (right)

Source: The author himself (2025).

Figure 24 illustrates the passage of the conduits through the EPS core. In this process, the core is melted using a heat blower, to later serve as a passage for the pipes, whether electrical or hydraulic. In addition, in Figure 25 it is possible to see the conduits arriving at the distribution board.

Figure 24 Passage of pipes through the foundation (left) and arrival of conduits in the EPS panel (right)

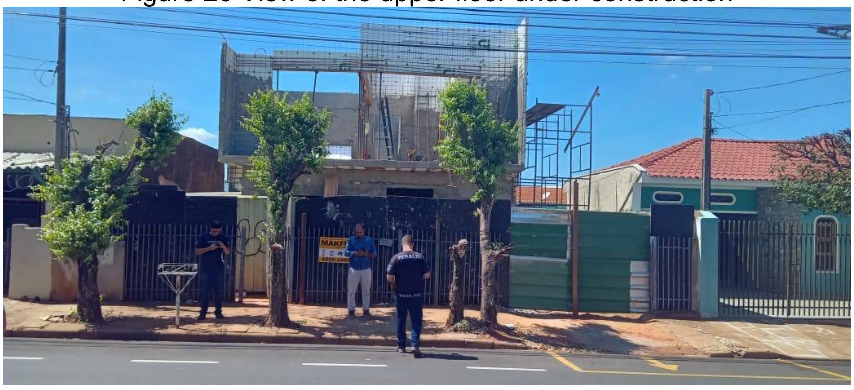
Source: The author himself (2025).

Figure 25 Detail of the switchboard attached to the panel in EPS

Source: The author himself (2025).

After 3 months of work, a new visit was made, and photographic records were made of the construction, now already in the implementation phase of the upper floor, as shown in Figure 26, up to the stage of coating with plaster; The short period demonstrates the agility of construction in this construction system.

Figure 26 View of the upper floor under construction



Source: The author himself (2025).

The staircase (Figure 27) and the elevator shaft (Figure 28) were also visited. On the side and steps of the stairs, an 8mm steel reinforcement was used.

Figure 27 Plastered EPS staircase (left), with detail for shoring it up (right)

Source: The author himself (2025).

Figure 28 Elevator shaft in the plastering phase

Source: The author himself (2025).

In this second visit, the construction stage of the floor slab was also recorded. Truss joists were used with infill in Styrofoam plates of the T1T type, which the acronym "T" means that it is not classified as flame resistant, as shown in Figure 29. The fastening of the rails to the panels is simply supported, with no additional steel reinforcement required. The pouring of the concrete should preferably be done on the rail, due to the lightness of the EPS plate, which can come loose during the direct pouring of the concrete on it, as shown in Figure 30.

Figure 29 Lattice slab rails (left) and completion of the one-room slab (right)

Source: The author himself (2025).

Figure 30 - EPS slab with concrete overhead at the corner of the slab

Source: The author himself (2025).

After concreting the slab, the finishing of the walls began, with mortar coating (Figure 31), subdivided into three layers: The first of them is a mass that has the function of chapisco (structural mortar) and the other layers were made with a mortar with a 6:1 ratio. The first mortar differs from the second in that it contains fiberglass and two additives, a plasticizer and waterproofing agent and another adhesive. The fiberglass has the function of containing the cracks arising from the exothermic process that occurs during the hydration of the cement, the waterproofing additive has the function of waterproofing the mortar panel and the adhesive additive of increasing the adhesion of the mass to the panel. In this work, the mortar was thrown to the panel manually, using a trowel.

Therefore, there is an additional cost in the production of mortar due to the use of such materials in the final product. At the end of the process, the plastered panel has a minimum thickness of 15 cm, which is the same thickness as a half-time wall of traditional masonry.

It is worth mentioning that the application of mortars is done on both sides concomitantly, because due to the lightness of the panel, it would tend to tilt if it were applied on one side at a time, which would harm the system, both aesthetically and structurally.

Figure 31 Plastering phase with structural mortar (left) and traditional mortar (right)

Source: The author himself (2025).

Figure 32 shows the mortar savings in regions where there will be no coating, such as light boxes, air conditioning passage, and bathroom niche. In addition, there is an ease in fitting the light boxes on the panel, with the area melted with a heat blower and the box fixed. Figure 33 shows the volume of waste generated in the work, considered low due to the versatility in the use and use of the EPS panel, which reduces the number of dumpsters needed for their collection.

Figure 32 Savings in mortar application in regions where there will be no coating

Source: The author himself (2025).

Figure 33 – Waste from EPS panels

Source: The author himself (2025).

In addition, it was possible to observe that during the walk on the upper floor, the structure evidenced the vibrations of the steps. This is the result of the direct relationship of the tying of the panels with each other, as the connection is made equally.

In addition, the connections made of furniture to the walls are efficient, as the screw fixing anchor expands in the mortar, and not in the EPS panel, ensuring the perfect stability of the furniture with the wall.

FINAL CONSIDERATIONS

From the panoramic study about the use of the construction system composed of reinforced mortar and EPS walls, seeking knowledge about the mechanisms of operation of this system, types of materials used, its advantages and disadvantages, as well as its applications through case studies, it can be concluded that monolithic panels contribute to the sustainable development of the country, evidencing the effective possibility of using this alternative construction system in the elaboration of civil works.

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