

Orthoblock Energy Performance Assessment And Comparison To Conventional Materials Used On The Building Sector

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Scope

The drive for sustainable development and energy efficiency in the building sector has increased the focus on the building material energy performance. As buildings account for a significant portion of the global energy consumption, there is a growing need for construction materials that reduce energy use and environmental impact. According to the statistics, the construction sector is the main culprit for the depletion of about 40% of our planet's natural resources, 40% of the available energy and 15% of the fresh water resources, while, at the same time, it produces about 25% of all waste materials and 40-50% of the various different pollutants which are considered to be the main sources of the greenhouse effect in our planet's atmosphere [1]. Energy-efficient building materials can help optimize the overall energy performance of structures, leading to lower operational costs and reduced carbon emissions.

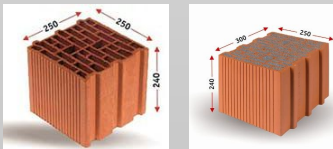
In response to these challenges, the building industry is increasingly adopting innovative materials and technologies that enhance energy efficiency. Materials such as the Insulated Concrete Forms (ICF), cool roofs, high-performance glass, and advanced insulation systems are revolutionizing the way buildings are designed and constructed. These developments are not only improving the thermal performance of buildings but also enhancing the comfort levels of the occupants and the indoor air quality.

The choice of materials used in the building sector should now be governed by the main environmental principles as first described by Brundtland in 1987 (Our Common Future) and the main points governing the circular economy. In this context, in 2010, the most important regulatory framework for the balancing of the country's building stock (old and new) was instituted in Greece, through the Energy Performance of Buildings Regulation (K.Ε.Ν.Α.Κ.). The institutionalization of the K.Ε.Ν.Α.Κ. it was an indirect admission of the failures and incomplete implementation of the pre-existing legislative framework for the thermal insulation of buildings, as it was first proposed and legislated in 1979 [2].

Moreover, regulatory bodies and industry standards are evolving to promote the use of energy-efficient materials in construction projects. Achieving higher energy performance in buildings is now a key objective for architects, engineers, and developers worldwide, signaling a fundamental shift towards sustainable and environmentally conscious building practices [4][5].

Over the last few decades, the ceramic industry has developed heat-insulating optical bricks of various categories, aiming to cover the thermal insulation coefficients required by the regulations (U-value, R-value), without the additional thermal insulation of XPS or EPS materials. In theory, this technology offers the opportunity to avoid the entrapment of the main structure of a building inside a casing of foam insulation. It allows for the breathing of the shell, avoiding the condensation of water vapor inside the masonry, the release of toxic substances from the interior spaces and significantly improves the quality of the indoor air. These advantages are negated when foam plastic insulating materials are placed inside the structure of the thermally insulating optical bricks.

The orthoblock brickwork can be described as bricks with specially arranged holes – gaps, with their thermal insulation capacity being provided due to the structure of the holes. The holes are arranged in such a way so as to form parallel zones of air gaps, throughout the stacks of bricks perpendicular to the direction of the thickness of the wall.



Methodology

This study will be examining the orthoblock building materials according to its energy performance, compared to the conventional building techniques used in Greece, as traced according to the construction techniques used up until 2010 where the building energy performance regulation took effect.

Moreover, there will be an evaluation of the energy saving percentage according to its overall U value, compared to the traditional building techniques and in the end, there will be an overall outlook on the building materials other properties, i.e. fire resistance, contained energy etc.

Results And Discussion

Orthoblock and its evolution ORTHOBLOCK PLUS (which is provided with XPS materials fillings), are ideal for building masonry techniques as well as load-bearing structures. It is a construction technique which involves the use of interlocking concrete blocks to build walls in a quick and efficient manner. These blocks are featuring a specific shape which allows them to fit together easily without the need for excess mortar or other adhesive materials. Orthoblock construction is known for its ease of assembly, durability, and structural stability. It is commonly used in residential, commercial, and industrial construction projects.

Their design with their interlocking connection, combined with their great mechanical strength, are offering the structure stability add to its anti-seismic characteristics (seismic energy absorption without damage). The heat-accumulating shell that is created with these building techniques is an excellent passive heat and humidity exchange system and allows the optimal use of energy, natural ventilation and day-night temperature change, in order to achieve great thermal comfort inside the building with minimal energy consumption. The construction is done with ease and speed (interlocking ensures their correct placement and only 16 pcs/m² are required), they are easily cut to the desired dimensions, they have special handles for ease of transport and installation and they offer great savings in heating and air conditioning. They are accompanied by a thin layer of mortar and metal brackets.

In comparison to the traditional and more widespread building techniques, the orthoblock construction technique provides benefits to:

- Considerable thermal insulation compared to common building techniques
- Fire and Beat Sound Resistance
- Structural Resistance
- Construction Speed/Ease of Construction
- Material transpiration
- Sustainability and recycling potential after the construction's lifecycle has ended

In comparison to the traditional and more widespread building techniques, the thermoblock building material (XPS insulated) provides considerable benefits to the overall U value. Presented below is a comparison between the overall U value of typical uninsulated masonry, the U value of a typically insulated masonry, the typical U values of the ICF building technique and the thermoblock masonry.

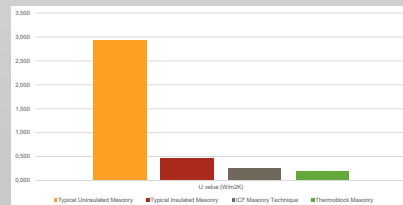


Figure 1. The Uvalue of each building technique

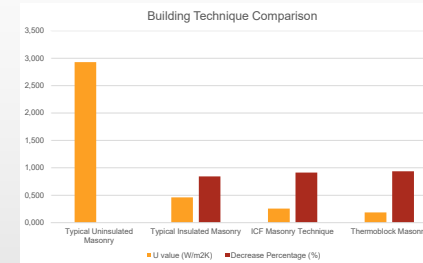


Figure 2. The decrease percentage of the Uvalue per building technique

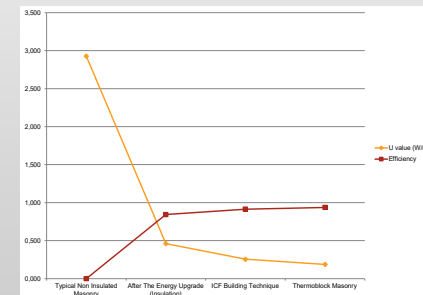


Figure 3. The efficiency increase according to the current Uvalue of each building technique

Conclusion

The design of the orthoblock walls, allows interlocking connection between each brick, combined with considerable mechanical strength, providing the structure stability. The heat-accumulating clay shell which is created is an excellent passive heat and humidity exchange system, allowing the optimal use of energy, natural ventilation, in order to provide thermal comfort inside the building with minimal energy consumption. The construction is done with ease and speed (interlocking ensures their correct placement and only 16 pcs/m²), they are easily cut to the desired dimensions, providing ease of transport and installation and compared to the conventional brickwork. Additionally, they are also providing considerable adhesive capabilities, requiring only a thin layer of mortar and metal brackets.

According to the results of the research, an important thermal property of optical bricks is the low speed of heat flow within their mass due to the presence of insulative material. They absorb or emit heat more slowly than other building materials, with the exception of clay. This property is important for balancing the temperature fluctuations in the interior spaces and for saving heating and cooling energy.

Additionally:

- The sound insulating properties of optical bricks are proportional to their thermal properties.
- The mechanical strengths of optical bricks depend on the composition of their raw material, their shaping and firing. Their prices allow the construction of up to a two-story load-bearing glass-brick structure, in the seismic environment of Greece, under the condition of strict compliance with the relevant specifications. Environmental properties
- The contained energy of ceramic products is low. The transport distances of the raw material to the potteries, as well as of finished products to the construction site, are usually very short. Energy is consumed mainly during firing.
- Clay raw material is abundant. It comes from areas of natural concentration of clay soils. Remediation of these areas is required after the clay reserves have been removed.
- The reuse of optical bricks is difficult, due to the adhesion of adhesive mortar residues on their surface. Solid old bricks are usually reused, for aesthetic and sentimental reasons. Brick demolition products are used in the form of ceramic chips in road construction as well as hard surfacing for sidewalks, fields and gardens. The recycling of clean pottery residues is immediate. They are converted into ceramic powder and added to the raw material for the production of new ceramic items.
- Pottery products are 'pure', made of earth, water and fire, with the exception of those containing harmful synthetic materials in their structure. During the firing of ceramic products, sulfur dioxide and hydrogen fluoride are emitted, harmful to the vegetation of the surrounding areas. Emissions are extremely dangerous (eg benzene), especially when the clay contains synthetic materials to increase the porosity of its mass. In modern ceramic factories, special filters must be installed, gaseous emissions must be controlled and treated, and suitable catalysts must be used.

Acknowledgements

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- [4] EN 771-1:2011+A1:2015
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