External Thermal Insulation Composite System ETICS

IN THIS PAPER :

External Thermal Insulation Composite System – or ETICS – is a compact multilayer insulation solution designed to improve the energy efficiency of both new and existing buildings. It is sometimes known as EIFS (Exterior Insulation Finish System) in North America.

PREPARED BY:

Rozhan Burhan Rafiq
Building Construction Engineer at General Directorate of Sulaimaniya Municipalities.
Kurdistan Engineering Union Member.
Member Serial Number :5093
Date of Join :30/07/2002

ABSTRACT:

Buildings consume a huge amount of energy, the most of which is used for heating and cooling. The financial and environmental benefits that building environmental assessment technologies provide to the construction industry are becoming more widely recognized.

This study provides an environmental and economic evaluation and comparison of several external thermal insulation materials, with a focus on insulation material selection. An evaluation method was used to evaluate a typical insulated cavity brick wall as well as External Thermal Insulation Composite Systems (ETICS) using various insulating materials (natural and synthetic). Using a specialized assessment approach, the impact of thermal insulation material selection on heating energy consumption, environmental impact, and the primary cost or benefit of the various wall systems was examined. The resulting grading system allows for a more accurate comparison and selection of building insulating materials.

This study aims to investigate not only the environmental effect of various insulating materials, but also the impact of using natural materials.

1. INTRODUCTION:

As people became more conscious of the environmental effects of their actions, they became more concerned about the availability of natural resources and the future of our world. The reduction of fossil fuel supplies, as well as the impacts of global warming on global climate, sparked a debate that lasted from the 1990s to the present. Many definitions of sustainable development have evolved in the literature, but the most often cited is one derived from the United Nations report Agenda 21: "development that satisfies the demands of the present without jeopardizing future generations' ability to meet their own needs" [Bourdeau, 1999].

As a result of heating, cooling, and lighting requirements, the built environment accounts for a significant portion of worldwide energy consumption. The energy necessary to heat, cool, and ventilate a structure is referred to as operational energy, whereas the energy required to generate building materials and components (raw material extraction, transport, and fabrication) is referred to as embodied energy [Paulsen, 2001]. The energy demand is determined by how effectively the building is insulated, and good insulation material selection may be critical in lowering operational expenses. By decreasing environmental burdens, it is feasible to develop in a more sustainable and cost-effective manner. One of the most difficult issues in this field of study is developing a set of universal standards that stay valid for the most regularly used construction materials.

Selecting insulating materials has proven to be a difficult undertaking, and several assessment techniques have been created to aid in the decision-making process [Papadopoulos, 2007].

Based on a study of multiple life cycle assessment methodologies, a set of criteria for the sustainable selection of building materials and products may be specified [Lucas, 2008]:

Low embodied energy – low processed or natural materials have lower embodied energy (cork is an example of a natural material suitable as a wall insulation product) High durability and low maintenance demand – selecting materials that become obsolete in a short term increases costs and generates more waste Salvage materials – a significant amount of materials are dismantled during the deconstruction process, some of which can be recovered and used in new constructions, avoiding the consumption of new materials. Materials derived from renewable resources – prevents the depletion of natural resources such as fossil fuel reserves Recycled and recyclable materials – materials entirely or partially produced with postconsumer components can reduce the extraction of raw materials

This research looks at the environmental and economic payback of several insulating materials (natural and synthetic) in two different wall systems. The selection of insulating materials is critical in sustainable building. Because of the substantial energy savings potential, making the right option has a significant influence on lowering environmental burdens and operational costs throughout the building's life cycle.

Thermal insulation in buildings has various advantages, including [Papadopoulos, 2007]:

Energy savings: decreasing dependency on electricity to maintain thermal comfort, therefore conserving energy and natural resources.

Environmental benefits: decreasing the usage of mechanical air conditioning machines leads in fewer pollution emissions.

Economic benefits: include lower running costs and lower initial investment owing to smaller HVAC equipment sizes.

Increased market value: lower customer expenses and improved building comfort conditions.

The most often used thermal insulation materials fall into one of the following general categories:

Polystyrene, polyethylene, polyurethane, cork, wood, and cotton are examples of organic materials.

Fiberglass, mineral wool, slag wool, vermiculite, and perlite are examples of inorganic materials.

Aluminium foil and ceramic coatings are two types of reflective membranes.

The selection of insulating materials necessitates a multi-criteria approach that takes into account [Al-Homoud, 2005]:

External environmental and health impacts include contributions to global warming, acidification, eutrophication, ozone generation, and waste management.

Energy consumption - total energy consumption that includes both fossil fuel and renewable energy usage.

Applicability - the performance of a material in terms of thermal conductivity, thickness, and so on.

Cost component - the cost as a function of the previously specified characteristics.

2 METHODOLOGY OF ASSESSMENT

Aside from the benefits of using insulating materials, its usage has environmental effects and expenses that must be examined and analyzed. MARS-H technique was chosen as an evaluation tool in this work since it reflects an attempt of adaptation to local conditions and solutions [Mateus, 2009]. Although this approach is utilized for building evaluation, it delivers accurate modifications and a trustworthy evaluation of structural systems and materials. Furthermore, the assessment is not limited to the environmental impacts. A full study provides for the relationship of this dimension with the social and economic implications, allowing for a more appropriate decision based on more than just those issues.

There are three steps to the assessment process. The degree of performance for each indicator is measured in the first phase. After categorizing the indicators (environmental, social, and economic), the level of sustainability is quantified. The parameters were quantified using the MARS-H assessment guide and the materials database [Mateus, 2009]. All parameters are subjected to a normalization procedure, which allows for a correct comparison with the performance reference and indication aggregation. The technique discussed here is based on a weighting scheme that aggregates the specified metrics to provide a performance summary of each investigated solution [Mateus, 2009].

This study compares an External Thermal Insulation Composite System (ETICS) to a standard insulated hollow brick wall, employing two distinct materials, extruded polystyrene (XPS) and agglomerated cork in both choices. Simply put, a cavity wall is made up of a double pane of 15 cm brick divided by a 4 cm wide hollow filled with insulating material (figure 1). The ETICS system (figure 2) is built around a single 22 centimetre brick wall with an outside 5 cm thermal insulation plate. Both walls are finished with a 2 cm covering [Lucas, 2008].

The impacts on the quality of the outdoor environment, the embodied energy, and the recycled content of the selected materials were considered while evaluating the environmental factors.

The original investment was taken into account while evaluating the solution's performance. Some MARS-H tool settings were not evaluated because the evaluation is about constructive solutions rather than a building project. As a consequence, the aggregation of indicators and the final grade are based only on the assessed criteria, resulting in comparative performance analysis.

Figure 1 shows a diagram of the double wall.

Figure 2 shows a diagram of the ETICS wall system.

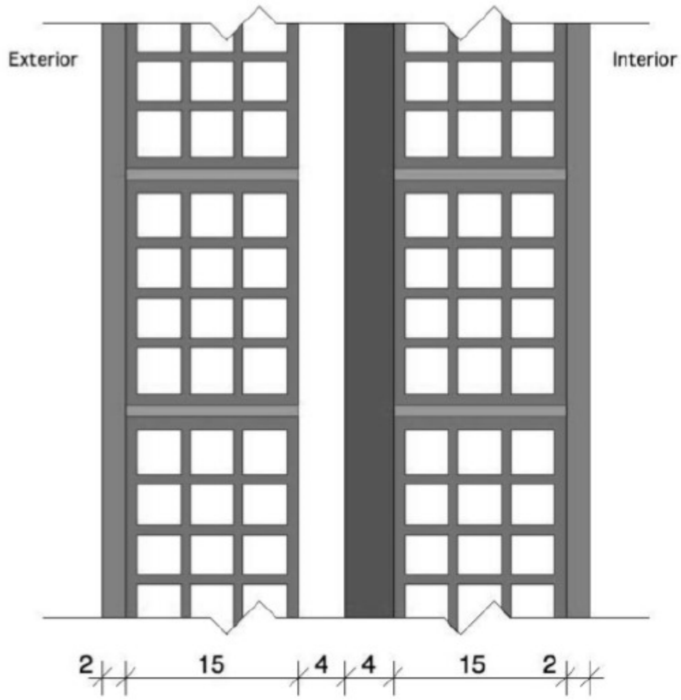


Figure 1 - Schematic representation of the double wall

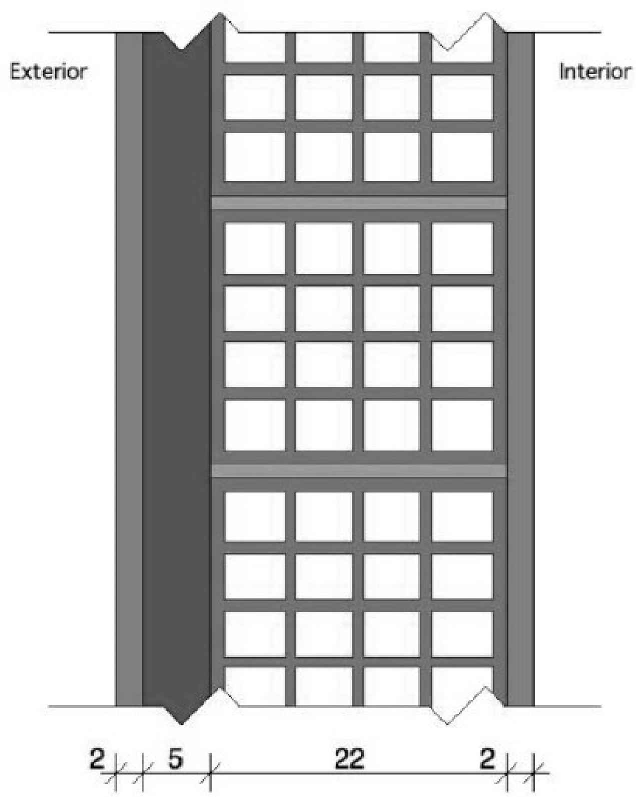


Figure 2 - Schematic representation of the ETICS wall system

How insulation works:

To comprehend how insulation works, it is necessary to have a fundamental understanding of heat movement, which is comprised of three primary mechanisms: conduction, convection, and radiation. When heat moves through things, such as when a spoon placed in a hot cup of coffee transfers heat through its handle to our hand, this is known as conduction. When heat travels through liquids and gases, convection occurs, which explains why lighter, warmer air rises and colder, denser air sinks in our homes.

Radiant heat travels in a straight line, heating everything solid that takes its energy.

Most common insulation materials work by slowing conductive heat flow and,

To a lesser extent, convective heat flow. Radiant barriers, which are not classed as insulation products, and reflective insulation systems work by reducing radiant heat gain. To be effective, the reflective surface must face an air space.

Heat flows from warmer to colder locations until there is no longer a temperature differential, regardless of the mechanism. In our homes, this means that in the winter, heat is transferred straight from heated living rooms to unheated attics, garages, and basements, as well as to the outside. Wherever there is a temperature differential, heat may move invisibly through.

Important properties of insulation materials:

The decrease of heat transfer (the transmission of thermal energy between things at different temperatures), between items in thermal contact, or between objects within the range of radiating effect is what thermal insulation is all about. Thermal insulation may be performed through carefully designed procedures or processes, as well as the selection of appropriate object forms and materials.

When items of various temperatures come into touch with each other, heat flow is an unavoidable result. Thermal insulation creates a barrier between the lower-temperature body and the higher-temperature body, reducing thermal conduction or reflecting thermal radiation.

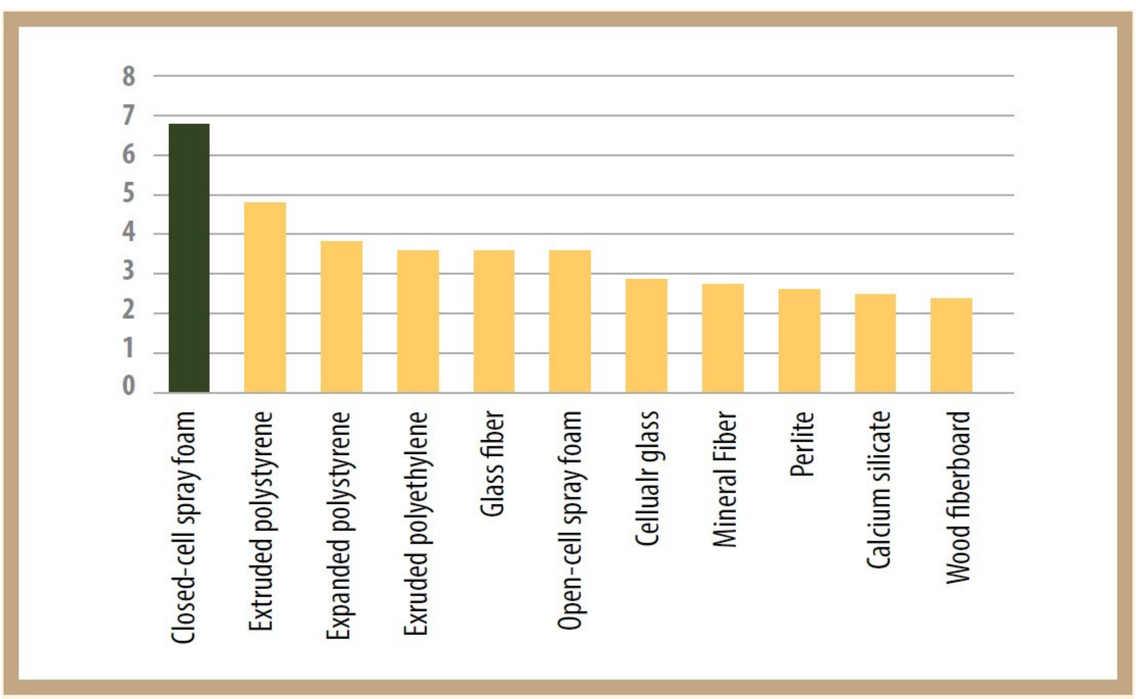
The thermal conductivity of a substance determines its insulating capacity; a low thermal conductivity is comparable to a high insulating capacity (R-value).

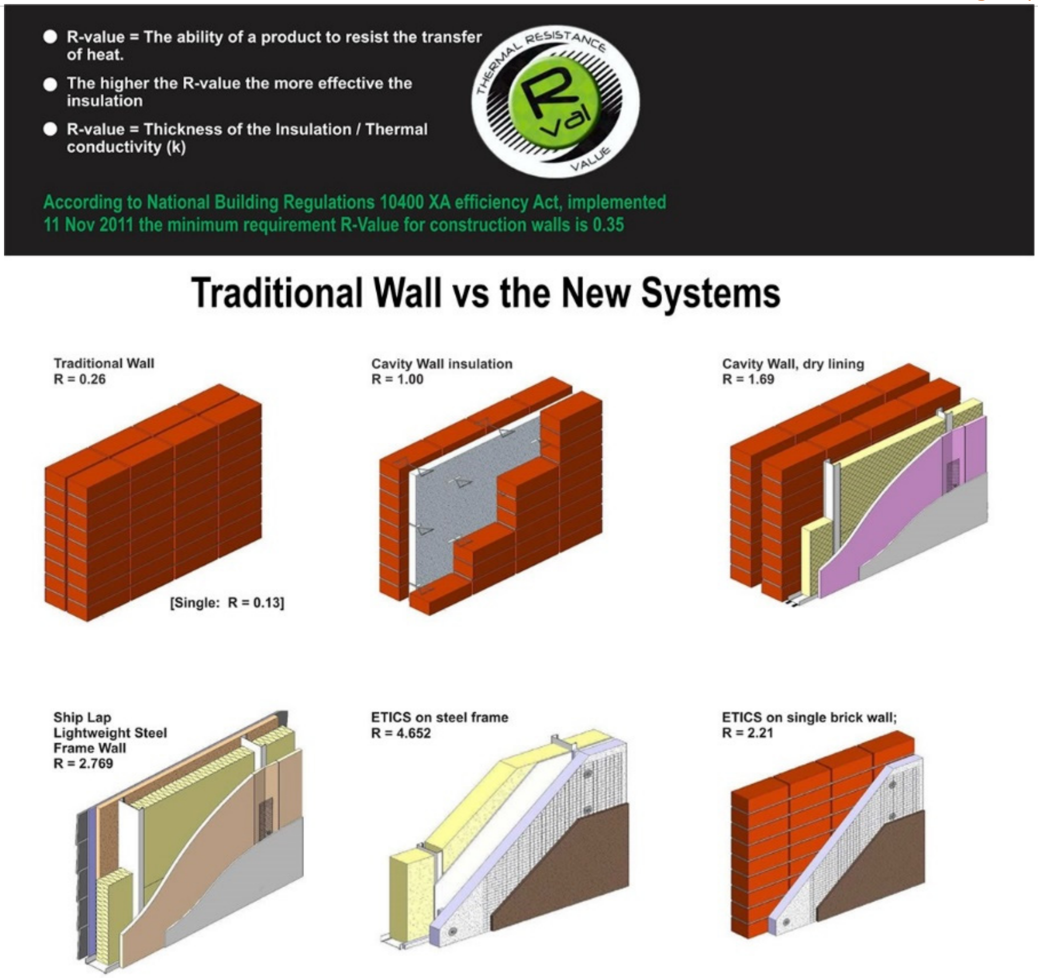
R-Value:

The resistance of an insulating material to conductive heat flow is measured in terms of its thermal resistance, or R-value; the higher the R-value, the better the insulator. The R-value of insulation is determined by its kind, thickness, and density. The R-values of the separate levels must be combined together when estimating the R-value of a multi-layered installation. The R-value of a house is increased by adding extra insulation, which improves the resistance to heat flow. Insulation professionals can assess the required level of insulation for any specific environment.

The efficiency of an insulating material's heat flow resistance is also determined by how and where it is put. Compressed insulation, for example, will not deliver the entire rated R-value. Because heat travels more readily through studs, joists, and other building components, the total R-value of a wall or ceiling will differ from the R-value of the insulation. This phenomenon is known as thermal bridging. Convective heat loss can also be reduced by insulation that fills building cavities densely enough to decrease airflow. The quantity of insulation required, or R-value, is determined by the environment, the kind of heating and cooling system, and the area to be insulated. The energy efficiency, health, and comfort of a house are all impacted by air sealing and moisture control

R- Value in some specific Insulation Material:





3. OUTCOMES AND DISCUSSION

The following MARS-H methodology categories were used to account for environmental impacts: global warming potential (GWP), ozone layer depletion (ODP), acidification potential (AP), photochemical oxidation potential (OPAP), and eutrophication potential (EP) [Mateus, 2009]. Figure 3 depicts the effect of normalizing and aggregating these groups. The embodied energy for each constructive solution was calculated using the same database, and the results are shown in figure 4. The examination of Figures 3 and 4 leads to the conclusion that the ETICS wall system with cork-based insulation has the best environmental performance. In reality, using cork as a thermal insulation solution helps to lessen environmental effect in both types of walls. It is obvious that using a natural material, especially in a double wall system, will increase environmental performance.

To summarize, when environmental loads and embodied energy are considered, the ETICS wall insulated with agglomerated cork produces the greatest results.

The economic performance of each option was evaluated based on its original cost (figure 5). The ETICS wall requires a greater initial expenditure than the typical double wall, and because agglomerated cork is more expensive, using this insulating material increases the original investment in both building methods. However, mass production of cork for this type of application may lead to a decrease in product pricing and a general decrease in the cost of this insulating option.

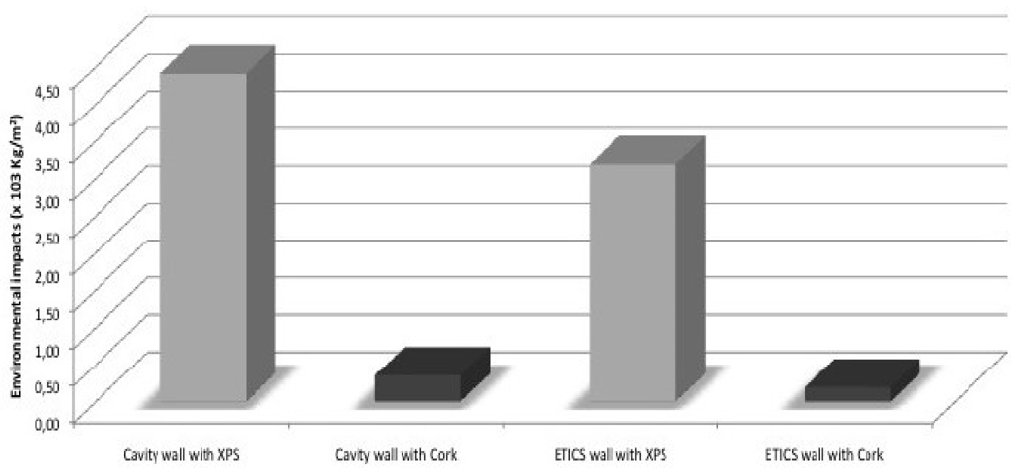


Figure 3. Environmental impact for each of the solutions under study (grey bars – walls with and without ETICS with XPS as insulating material; black bars – same as previous but with cork as insulating material.

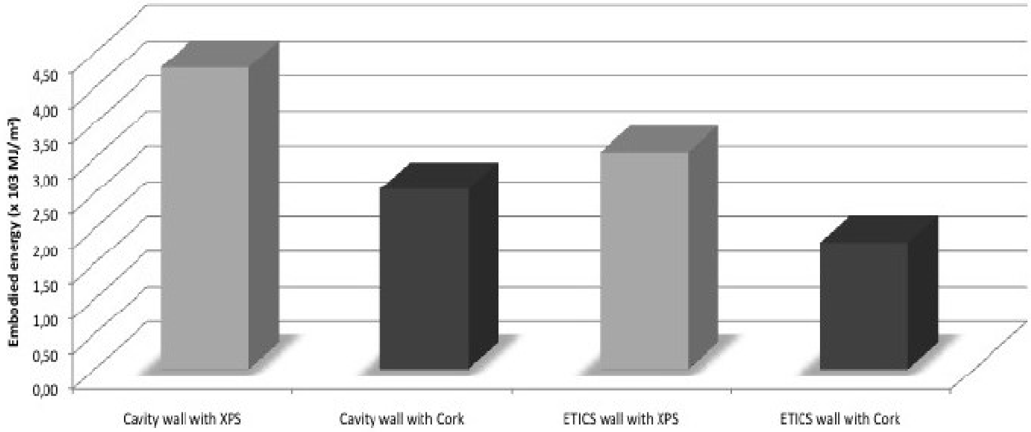


Figure 4. Embodied energy for each constructive solution (grey bars – walls with and without ETICS with XPS as insulating material; black bars – same as previous but with cork as insulating material).

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Following the evaluation of the various parameters, they are combined using a weighting mechanism that determines the level of sustainability for each option investigated in this study. According to the study that led to the MARS-H evaluation method [Mateus, 2009], the environmental component was given a weight of 40% and the economic dimension was given a weight of 30%. The same Chapter 6: Case-studies weights were used in this assignment. Because evaluating the social component would be achievable only in a complete building project, this dimension was not examined in this study.

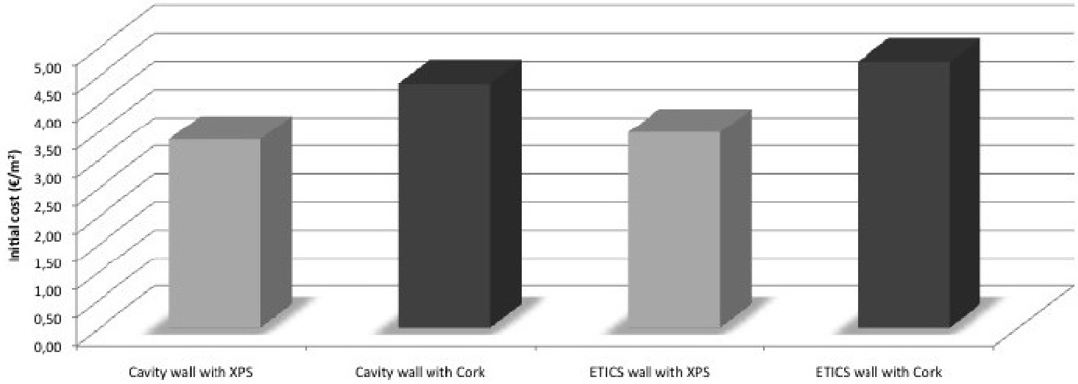

Figure 5. Initial cost for each wall system (grey bars – walls with and without ETICS with XPS as insulating material; black bars – same as previous but with cork as insulating material).

The global performance on the environmental and economic dimensions, considered in this study, is presented in Figure 6 in a form of final classification for the different constructive solutions considered. Despite the higher initial price, when the parameters are aggregated in the final classification, the choice for insulation with agglomerated cork always presents a superior sustainability level regardless the wall system.

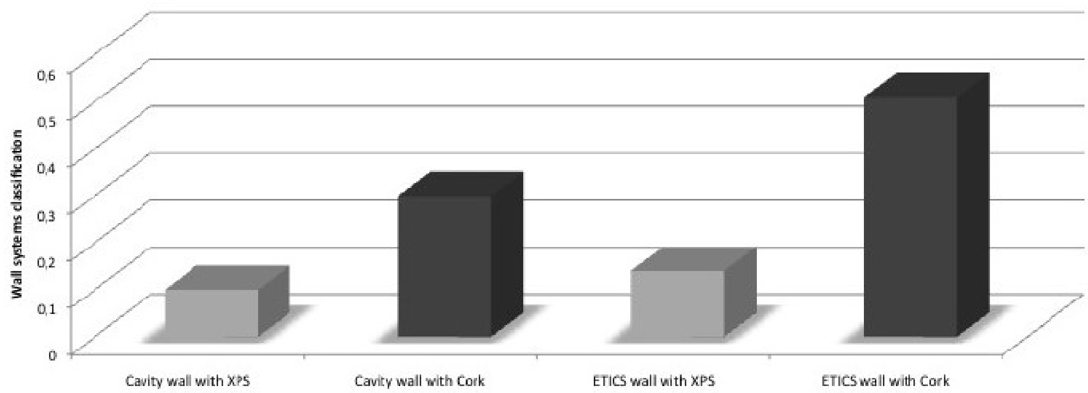

Figure 6. Global classification of the constructive solutions (grey bars – walls with and without ETICS with XPS as insulating material; black bars – same as previous but with cork as insulating material).

Hence, the ETICS wall with cork achieved the best global result, concluding that after evaluation of the environmental benefits, the embodied energy and the initial investment, this solution turn out to be the most suitable.

4. ENDORSEMENTS

The materials selection procedure is critical for developing long-term sustainable and inexpensive structures. The use of an appropriate evaluation tool may be a valuable resource for builders and designers, maintaining the selection process and enabling a confident choice. The MARS-H technique has shown to be such a tool, allowing not only the categorization of sustainable buildings, but also the evaluation of materials for various constructive solutions, as provided by Portugal SB10: Sustainable Building Affordable to All. All necessary additional information for the design process.

The results show that regardless of the insulating material used, the ETICS system is a better choice.

Natural materials used in building insulation help to equitable thermal comfort while enhancing overall performance. Despite the fact that agglomerated cork requires a larger initial investment, it has significant environmental benefits because it is a natural material generated from renewable sources. Because this is a natural substance that is abundant in Portugal, its usage helps to develop the local economy while also having a beneficial social impact in local communities. The economic benefits of employing natural materials should not be evaluated just on the basis of their original cost. It must be viewed as a long-term investment with long-term benefits such as the preservation of fossil fuel reserves, increased durability, and fewer emissions.

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