

Feasibility Analysis of Applying Thermal Insulation Composite Wall in Residential Buildings

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Abstract— From the point of view of existing rules for energy conservation and fire-avoidance, similarly as prosperity, the standard advancement of warm protection of outside divider is ending up being progressively increasingly inadaptable to necessities for outer divider warm protection of private structures. The paper is searching for an arrangement of outside divider warm protection development appropriate for private structures by assessment of physical mechanic's execution and development procedure of warm protection composite divider. The paper dependent on the excellent moderate lodging ventures in Famagusta, Cyprus investigates a practical outside divider warm protecting framework to meet the trademark necessities of little size reasonable private lodging with exacting cost control, improve the nature of the prosperity venture for instance the reasonable lodging by and large..

Keywords— Thermal Bridge, ETICS, Insulation, Energy Saving.

I. INTRODUCTION

Vitality utilization is one of the significant issues of current life. The vast majority of the vitality we go through originates from petroleum products. We need to spare vitality since the constrained assets are accessible and those powers cause critical natural contamination. The vitality sparing is kept up by lessening the vitality utilization in structures. There are a couple of approaches to lessen heat misfortune, one of which is to apply an ideal protection thickness to outer dividers. [1]

Thermal Insulation Composite Systems in any case called ETICS are much of the time used Europe since the 70's, both in new structures and in retrofitting. The ubiquity of this innovation became because of its preferences in regards to different procedures of protection. ETICS guarantees the decrease of the warm extensions and more prominent warm solace because of the higher inside warm dormancy, giving a completed appearance like the conventional rendering. From the development perspective, ETICS permits slenderer outside dividers and builds the veneers' sturdiness. To the sharp focal points, three extremely pertinent

viewpoints in the development business must be included: minimal effort, simplicity of utilization, and plausibility to be introduced without upsetting the structure's occupants, which is especially significant in fix. Warm Insulation Composite System has different qualities, for example, Thermal Insulation.

- Stability
- Waterproofing
- Mechanical strength

Thermal Insulation Composite Wall should also meet the minimum requirement for fire safety. The system is available in different types, designated by the choice of the insulating panel material. Their Thermal conductivity ranges from $\lambda:0.032$ W/mK to 0.040 W/mK [1].

It is composed of:

- Mapetherm AR1 Adhesive [1],
- Mapetherm Net reinforcement Mesh [1],
- Mapetherm Mineral wool insulating panels / XPS or EPS [1],
- Mapetherm Anchors, Silancolor Base Coat [1].

The thermal protection of the outer dividers from the outside is the most proficient method for the structure assurance against warm vitality misfortune. A significant bit of leeway of this framework is the protection of a structure all in all, which completely forestalls the warm scaffolds, temperature load, climate related harms of the divider structure and buildup on the structure. It additionally gives stockpiling of warmth in the divider and advantages the divider warm protection from making a progressively agreeable condition in the structure. As indicated by ETAG 004 [1], ETICS are frameworks including pre-assembled protection boards, fortified or potentially precisely fixed onto the divider, and strengthened rendering, comprising in at least one layers and applied straightforwardly to the protection. These frameworks ought to give negligible warm opposition in overabundance of $1 \text{ m}^2 \text{ K/W}$. Ordinarily, in the Portuguese market, the protection boards are extended polystyrene (EPS), adhesively joined to the substrate and secured with a base coat fortified with

fiberglass work. The completion coat is a slender acrylic-based rendering (Figure1).

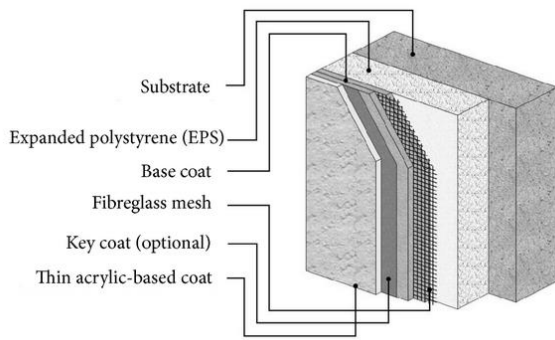


Figure 1: Schematic example of ETICS available in the Portuguese market [2].

The main advantages of ETICS, which have boosted its commercial growth, are [2, 3, 4] as follows:

1. Energy savings: Reduces heating and cooling costs.
2. Improved comfort: Increased thermal comfort for occupants.
3. Internal space saving: The insulation is applied on the external wall rather than the interior one. Further, if installed on existing facades, there is no disruption to the internal space as it is installed on the outside.
4. Aesthetically pleasing: High variety of finishes.
5. Ease of application: Suitable for application on new and existing buildings. The cost also to install it in new buildings is low as it uses less material and minimizes the construction time.

II. TYPES OF THERMAL INSULATION MATERIALS

There are a lot of modest and normal insulation materials accessible available today. A large number of these have been around for a long while. Every one of these protection materials has their own high points and low points. Subsequently, before choosing which protection material is appropriate, consideration ought to be paid to which material would work the best in your circumstance.

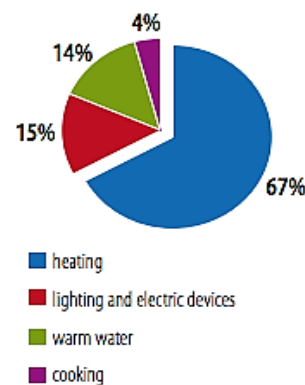
We have considered contrasts like R-esteem, cost, ecological effect, combustibility, sound protection and different factors beneath. Here are the 5 most normal sorts of insulation materials: In cold regions the external wall is built as composite structure, which is generally formed with bricks in outside, insulation at the middle and plaster layers on both sides. Stropor (k ¼ 0:030 W/m K) of 3, 4 and 5 cm thickness is commonly used as insulation material.

Insulation Material	Cost	R-Value / Inch	Environmentally Friendly?	Flammable?	Notes
Fiberglass	\$	R-3.1	Yes	No	Does not absorb water
Polystyrene (EPS)	\$	R-4	No	Yes	Difficult to use around imperfections
Mineral Wool	\$\$	R-3.1	Yes	No	Does not melt or support combustion
Cellulose	\$\$	R-3.7	Yes	Yes	Contains the highest amount of recycled content
Polyurethane Foam	\$\$\$	R-6.3	No	Yes	Makes a great sound insulator

Figure 2 Types of Thermal Insulation materials (URL1)

III. CRITERIA FOR THE SELECTION OF SUITABLE INSULATING MATERIALS

- Thermal conductivity: this indicates how much heat is lost externally through the insulating material.
- Water vapor diffusion resistance factor μ : the higher this value, the fewer vapors penetrates into the material, which has a positive effect on the energy efficiency.
- Gross density: this describes the ratio between the mass to the volume of the ETICS. Lower density facilitates better insulation. The thickness of the insulating material can be reduced with a higher density.
- Primary energy concentration: this indicates how much energy is required to manufacture an ETIC system from obtaining the raw materials through to the end product.
- Materials class: this determines the flammability properties of a material.



Graph 1: Heating is the main source of energy consumption of buildings.

IV. COST ANALYSIS

The markdown rate utilized when displaying LCC is up to the individual financial specialists, however it ought to compare to the pace of return of other comparative

tasks or prerequisites for explicit kinds of open undertakings. A 5% rate is ordinarily utilized [5]. Expenses emerging for the duration of the existence pattern of a structure at that point comprise the procurement costs, operational costs (support, fixes, substitution) and removal costs. For the reasons for the present research action, the rebate rate was set at 5%. The precision of cost expectation relies upon different perspectives including the degree of data detail on the structure [6] (materials, conditions under which certain exercises can be done, e.g., the cleaning administration [7]) and data about materials and related information on crumbling conduct [7]. The solidness of an ETICS framework is approximated at 80-100 years and the cycle for support is recommended to be 40-55 years (Sternová Z. et al. 2001). For warm protection frameworks with protection material based on polystyrene and mineral fleece applied legitimately on the dividers ETICS are acknowledged the normal expenses for one bundle of protection – \$34/sq.m for polystyrene and \$40/sq.m for mineral fleece. Considering the normal market costs the expenses are in the scope of \$25-31/sq.m just for the materials. Market costs are typically decided by the unpredictability and volume of the request, material costs, territory of the building site, and so forth. (Mihaylova, 2015).

VI. PROCESS OF INSTLLATION

Fixing the insulating materials to the supporting wall can happen in a wide range of ways. One choice is to fix the ETICS to the divider utilizing unique, modified glue. There is additionally the blend of cements and dowels just as mechanical mounting utilizing tracks. The sort that is utilized relies upon the protecting material chose, its weight and the base. For instance, it isn't allowed to utilize cements with mineral fleeces. Dowelling must be utilized for this. The body of the composite warm protecting cement punctured block is basically framed from concretes and sandstones experiencing certain composite procedure in order to meet vitality sparing prerequisites of private structures. Subsequently the procedures of establishment of ETICS are as per the following:

- Surface Preparation
- Surface Priming
- Tear Test
- Fixing an Insulation Layer
- Fixing the Reinforcement Mesh
- Preparing the surface for plastering
- Application of Plaster
- Painting

V. CASE STUDY

Analyzing and comparing a case study through qualitative research methods employing life cycle analysis carried out this action research. The life cycle cost of using Thermal Insulation Composite Wall was compared to the current consumption from the local electric source, to find the more sustainable option in terms of cost and energy efficiency. (Figure 3) The comparative analysis will be done using calculation, based on the given data from the properties of each of the systems to see which is preferable using the Present worth Method.

- Type A- No Thermal Insulation Composite Wall
- Type B- With Thermal Insulation Composite Wall

The comparison will be done based on the same amount of energy demand by the selected residential building to determine the cost effective system over a time period of 20 years.



Figure 3: Betsa 2 Apartment (Picture taken by author)

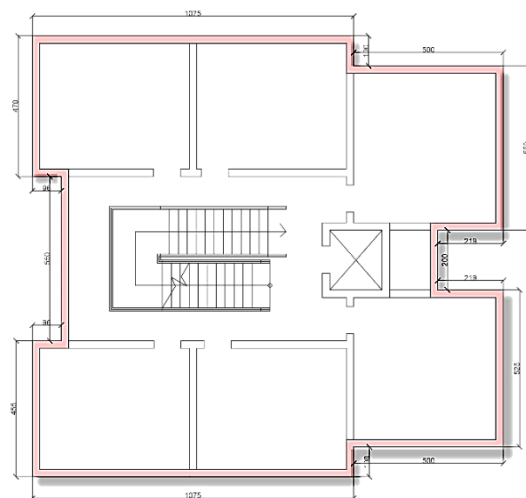


Figure 4: Typical Floor Plan of case study building

TYPE A

According to the building management, there are 25 units in the building and every unit uses up to 300Kw per month which goes for 0.17\$ per Kw.

SOLUTION

300Kw per month x 12 = 3,600Kw per year

25 units x 3,600 = 90,000Kw per year

90,000Kw x 0.17\$ = \$15,300

Interest Rate 5%



? \$15,300

$$P = (P/A, 5\%, 20)$$

$$P = 15,300 (12.4622)$$

$$P = \$190,671.56$$

TYPE B

Number of floors = 5 floors

Total length of walls (1 floor) = 67.3m

Height of Wall (1 Floor) = 3m

Electricity Usage = 35% of heat and electricity expenses.

Cost of thermal insulated composite wall per m2 (mineral wool)= \$40/m2

Life span of Walls = 20yrs

Total Wall Area = (67.3 x 3) m2 x 5 = 1,009.5m2

Initial Cost = total wall area x cost of ETICS = 1.009.5m2 x 40\$= 40,380\$

35% of \$15,300 = \$ 5,355



\$40,380

\$5,35

$$P = \$5355 (P/A, 5\%, 20) + 40,380$$

$$P = \$5355 (12.4622) + 40,380$$

$$P = 66,735.08 + 40,380$$

$$P = \$107,115.08$$

VII. CONCLUSION

Based on the results obtained from the comparative calculations, it is observed that the cost of energy production from thermal insulated composite exterior walls is less than none insulated brick walls. Therefore, the thermal insulated composite system is strongly advised to be applied to the building.

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