Polystyrene Thermo Insulation Performance Comparison

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ABSTRACT : *The goal of this project is to compare the performance of a thermally insulated wall to that of a non-insulated wall. Parallel to the comparison, useful statistics will be generated in order to better understand the advantages of thermal insulation materials and the efficiency of the facility where they are used. Thermal insulation will be the primary focus of our efforts. Concrete examples will be treated in the city of Tirana in order to further enhance the study. Many changes in our country's design idea, including legal and technical aspects, have occurred in recent years. Energy efficiency has become a critical consideration in the construction of institutions. And is expected to be developed even further, thus raising interesting in making such research for this topic.*

KEYWORDS –efficiency,structure, insulation,testing, data, comparison.

I. INTRODUCTION

The process of preventing heat from moving between two or more surfaces is known as thermal insulation. To achieve such material performance, a variety of strategies are employed.

Insulators, or thermal insulation materials, can reduce the demand for other heating systems, lowering the building's overall energy usage. They've become a critical component in the creation of high-quality structures and a significant increase in efficiency.

The flow of heat through the insulating material must be resisted in order to produce thermal insulation. As a result, any heat transfer mechanism should prevent heat from flowing across adjacent.[1]

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

Fig.1- 5 most popular insulators (table)
Source: thermaxxjackets.com

II. CURRENT CASE STUDY

We chose to conduct this study to learn more about the temperature difference in a thermo insulated wall. The thermo insulated wall we chose is based on a relatively new building in Tirana that uses polyester as a thermal insulator in both the interior and outside walls. Both of the walls in this comparison are made of concrete.

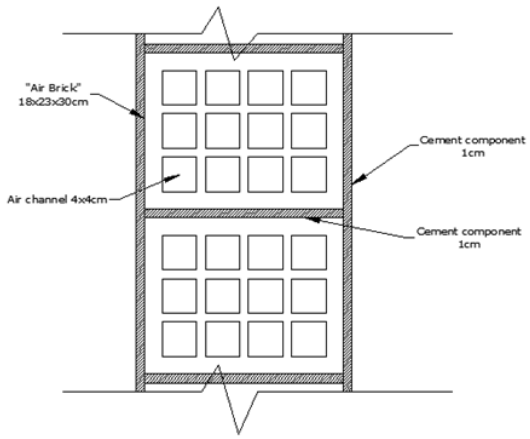

Fig.2 Wall A(not insulated) section cut
Source: Author.

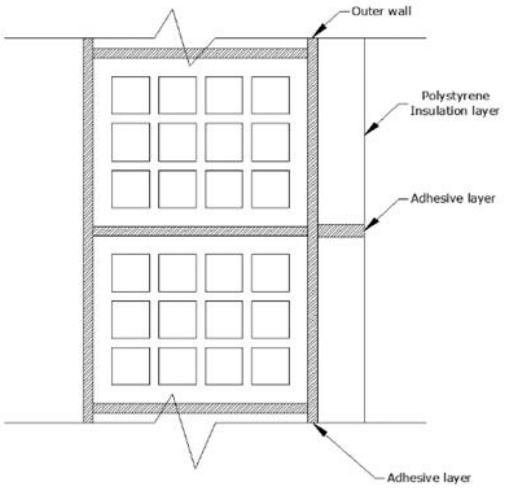

Fig.3 Wall B(insulated) section cut
Source: Author.

III. WHAT IS POLYSTYRENE THERMAL INSULATION?

Polystyrene is a synthetic polymer. Polystyrene can be found in two main types solid or foamed. This material is a transparent thermoplastic and contains the right properties to be a great thermo insulator. Such properties also make it easy to install and able to fit different types of spaces.[2]

IV. HOW IS THIS FORM OF INSULATION INSTALLED?

1-Preparing adhesive for polystyrene.
Prepare adhesive for polystyrene boards in a bucket. The mortar we'll use is designed specifically for gluing polystyrene to concrete exterior walls. To make the adhesive, we must first fill 1/3 of the bucket with water, then add the premixed ingredient.[3]

Fig.4 Mixing the adhesive
Source: howtospecialist.com

2-Mixing the compound.
Next, we must properly mix the compound in order to secure the polystyrene boards to the concrete wall. We can mix the mortar in one of two ways: manually using a cloth or with a drill mixer. The drill mixer is preferred for better mixing.[3]

3-Applying the mixed compound on the polystyrene.
Apply mortar along the borders of the boards with a towel, as shown in the figure. Because you won't be able to effectively fix them on the concrete wall if the adhesive thickness is larger than 2.5cm. A homogeneous layer of glue on the wall can also be achieved by applying an even layer of adhesive.[3]

Fig.5 Applying the adhesive.
Source:howtospecialist.com

4-Installing the polystyrene sheets.
We must mount the polystyrene sheets horizontally on the concrete wall after we have applied the adhesive to them. As a result, start installing the boards from the bottom corner of the wall and work your way up.
Double-check that the sheets are exactly aligned. After that, gently press on the wall to secure them. After that, you must use a level to ensure that the wall is absolutely plumb, as once the mortar has dried, it will be hard to correct the error.
Install the polystyrene sheets until the row is complete. Ascertain that the boards' edges are parallel.[3]

Fig.5 Installing the (EPS).
Source:howtospecialist.com

5- Securing the insulation with dowels.

You can start drilling holes through the insulation layer in the concrete wall to place the special dowels after making sure the polystyrene mortar has dried. As a result, in order to bore holes in the concrete wall, you should use a good drilling machine with a hammering function and a drill bit (usually#10).

Otherwise, you won't be able to correctly install dowels since the drilled hole is 5-7cm longer than the thickness of the polystyrene. It's also crucial to remove any residue from the perforations.[3]

Fig.6 Securing the (EPS).
Source:howtospecialist.com

V. GATHERING OF INFORMATION.

5.1 The device.

This information has been possible by using two main items for this research. They're the "Testo 925" Temperature Type K measuring instrument. This device has two main components that have been used for this research.Firstly the first module which connected with the wall through 3 wires placed in a triangle shape in the desired area for analyzing and the outdoor module which is set on the same height as the indoor wires and 50cm far from the wall. The modules are set in an automatic mode where they calculate the temperature of the wall once per minute, in an interval of 4 hours is required to complete the results. These are very important steps in completing a successful data gathering which will be later used for this research. The same process was applied in both walls in two different days. A very important factor is the weather where heavy rain or wind would compromise the accuracy of the results. Luckily these tests have been mane in the proper conditions. The last requirement for this test was a difference greater than 15°celsius between indoor and outdoor temperature.

Fig.7 Testo 925 device.
Source:testo.com

5.2 Locating the buildings.

Both of the buildings that were chosen to gather data for this study are located in Tirana. Fortunately, because both buildings are close to the center, they have nearly identical climate variances. They also have the same reinforced concrete structure with beams and columns, as well as brick walls. This information is gathered on the brick walls.

This is the first building and is located very near the center of Tirana and it was chosen because it has no thermo insulation. Is a relatively old building that was constructed around 2003-2004. The analysis was made on the first floor of this building on the North side at a height of 5.5m. The brick wall is 23cm thick and has 2cm of cement layers on both sides that sums up the thickness to 25cm.

Fig.8 Location of building A.
Source: Google map.

The second building is also located Tirana near the center. It shares the same properties of the first building regarding the structural typology except the

fact that uses Polystyrene thermo insulation and is the main reason why we chose this exact building. The measurements were taken in the eleventh floor of this building at a height about 41.5m in the North wall.

5.3 The testing parameters.

This study necessitated various specifications in order to ensure that the testing findings were completed correctly. The key reason for doing the testing at night is to ensure that the temperature of the wall is not affected by the daytime temperatures.

Fig.9 Location of building B.
Source: Google map.

The tests were conducted over two days, one for the insulated wall and the other for the basic wall. It was made sure that we followed the test's main condition, and both tests were conducted from 8:00 p.m. to 12:00 p.m. On the 13th and 14th of January 2022, respectfully.Firstly, both rooms where the chosen wall for the investigation was constructed were heated to provide a temperature difference between inside and outside temperatures of larger than 15°. On January 13th, the external temperature was 6° and the inside temperature was 22°, as indicated below. On the other hand, on January 14th, the external temperature was 8 degrees and the internal temperature was 24 degrees. As previously stated, we complied with all technical requirements in order to obtain accurate results in terms of device location against the wall.

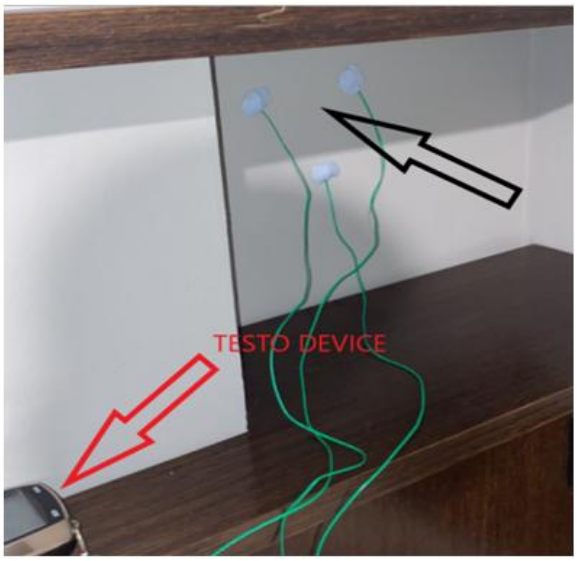

Fig.10 Placement of sensors and device (In pic. Wall A: Source: Author.

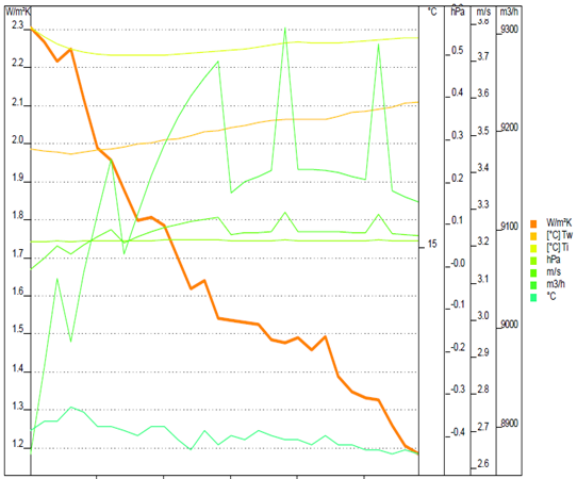

Fig.11
Graph results from wall A.
Source: Testo 925 software.

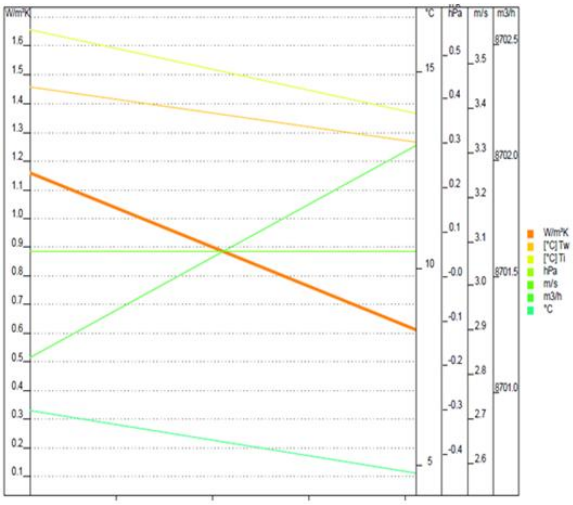

Fig.12
Graph results from wall B.
Source Testo 925 software.

5.4 Test Results

The rate of heat loss through a roof or wall structure is measured by thermal transmittance, or U-value. It's measured in watts per square meters per Kelvin degree (W/m2K). The orange line is visible in both graphics. And this is the most important finding from the study. The major conclusion is clearly evident in the images, with an obvious differences of thermal energy loss in Wall B compared to the graphic's fairly neutral and linear line with the test findings from Wall A.[2]

Fig.13 Device in process Source: Author

VI. Conclusions

The performance of the thermo insulated wall showed a very good performance regarding energy loss compared to the not insulated wall. Considering no heating was used during the time the device was getting results, the thermo insulated wall reduced the drop of energy and consequently the temperature of the wall. This simple graph proved Polystyrene is a great performer as thermo insulator and fulfills all the requests may that be economical or engineering

On the opposite side, the poor performance of the not insulated wall shows that it should be recommended to avoid not insulating the building in future building as it contributes into using non environmental and high energy consuming heating methods.

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