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The impact of expanded polystyrene usage on buildingsthermal insulation– Case of Tirana, Albania

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Abstract: Thermal insulation is an important component in nowadays construction.Considering that before 90s Albania had been undeveloped enough, there was no needed information for thermal insulation's importance, as well as missing materials and economic hardships to provide them. Consequently, many objects built during this time are not thermal insulated. Nowadays, its application is being more and more significant and convenient due to its benefits.In our country, a lot of attention has been paid to the application of thermal insulation, since 1990s. The main reason is the energy efficiency.Energy consumption is directly affected by its preservation. Moreover, it is crucial to mention the comfort that is offered.To give solutions to these housing challenges, is important to find the appropriate materials.During the latest years, more and more materials are highly standardized in contemporary expectations. One of these materials that is widely used in thermal insulation is expanded polystyrene. The benefits that the material has in terms of insulation, durability, moister resistance, and energy efficiency are important. In construction, insulation continues to function under a variety of temperature, humidity, and other conditions. The impact of expandedpolystyrene in thermal insulation of buildings is the main subject of the study.This study should take in consideration the thermal insulation (EPS) applied in a building in the city of Tirana and another building where there is no application of thermal insulation. A comparative analyse between them should be applied by using a specific instrument, which calculate the U-value taking in consideration all layers of the wall and three components of temperature: indoor temperature, wall temperature and outer temperature.

Keywords: Polystyrene, EPS, thermal insulation, comfort, energy efficiency, u-value calculate

1. Introduction

Over the years, the globe is facing a steady increase in population, and this is being accompanied by the need to expand built-up areas. In addition, the need for energy, especially the one that is used for buildings' heating systems increases. Because of non-renewable sources reduction, building industry is heading to other ways to providethe needed energy, one of the sources is thermal insulation. It is proved that thermal insulation offers thermal comfort and a health friendlyenvironment. If the presence of thermal insulation is missing, the building will have large energy losses, which also causes economical damage. According to studies not insulated exterior walls are the most important zones for heat losses. To avoid this, the perimetral walls must be insulated and thermal insulation has more benefits when insulating exterior walls.

Throughout the measurements and comparative analyse will be drown results. In recent years, there has been an incasement in the application of polystyrene for construction industry. Polystyrene is a polymer that is cheap and easy to process.According to some studies the polystyrene material benefits of high thermal conductivity, is one of the most economic materials and is a lightweight one.This material is found in various forms, is easily applicable and presents well its chemical, physical and mechanical peculiarity. Furthermore, this material is environmentally friendly, which is something that is given much more importance during the latest years in construction.Apart from that, polystyrene has a high thermal insulation and low weight by reducing the weight of building. Considering unit weight, which is very low when compared with other materials, it is seen that product of polystyrene foam material's compressive strength has an important higher value.(fig.1)

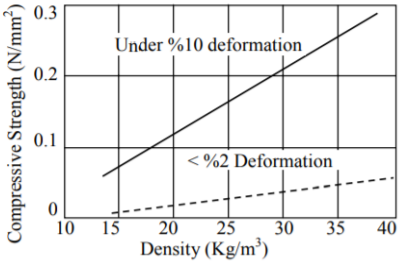

Fig.1. Compressive strength of EPS according to density & deformation.

Expanded Polystyrene, or EPS, is a lightweight, rigid, plastic foam insulation material produced from solid beads of polystyrene. Expansion is achieved by virtue of small amounts of pentane gas dissolved into the polystyrene base material during production.The gas expands under the action of heat, applied as steam, to form perfectly closed cells of EPS.It can be used as insulated panel systems for facades, walls, roofs, and floors in buildings.


Fig.2. Fig.3. Application of EPS as insulated panels

2. Methodology

This study seeks to investigate the thermal behaviour of EPS as insulating material. For these measurements are chosen two buildings in capital city of Tirana. One of the buildings has the benefits of EPS thermal insulation. While the other building is in lack of it.The performance of thermal insulation in these buildings will be obtained with the aid of a specific instrument.By means of this instrument will be calculated the U-valueor thermal transmittance.

U-value is the rate of transfer of heat through a structure, divided by the difference in temperature across that structure. The units of measurement are W/m²K.

The instrument that is going to be used isa Temperature probe to determine U-value. The U-value is the most important value used to rate the energy efficiency of building components. Three temperature values are needed to determine the U-value: outer temperature, surface temperature of inner wall as well as indoor air temperature.Using the new wireless probes, the outer temperature can be quickly and easily measured with the window closed(the characteristics of the windows are not taken into consideration). The probe is simply positioned outside and transmits readings by radio to the measuring instrument in the room. With the new patented U-value probe the two other temperatures required are measured using one probe. To measure surface temperature, three wires from the U-value probe are attached to the inner wall using modelling clay. The air temperature is measured by a sensor on the probe plug. The three temperatures needed are determined by the connected temperature probes and transferred to the testo 435. The instrument calculates the U-value from them and shows it directly in the display.



Fig.4. Testo 435-2 - Indoor air quality meter.
Fig.5. Temperature probe to determine U-value, triple sensor system for measuring wall temperature, modelling clay included.
Fig.6.Radio handle for plug-in probe heads, incl. T/C adapter.
Fig.7. T/C probe head for air/immersion/penetration measurement (T/C Type K).

3. Current case study

Through this study we will observe the difference between two typologies, a thermal insulated wall, and a non-thermal insulated wall. Both walls are made of concrete.

The chosen objects are built in different periods. The thermal insulated one is built in recent years. The insulation in this building has been applied to the external walls.

3.1 The location of buildings

Both buildings are located near the city centre. Given that they are close to each other, the climate conditions are the same. Buildings' have also the same typology, that consists of reinforced concrete with beams and columns, and brick walls.

Building A

Building A is in the Panorama Street near the centre of Tirana. It is built circa 2012-2013and, in this construction, has been applied the thermal insulation with polystyrene. The measurements were conducted on the 11th floor, on the northern external wall.

Building B

The second building is also located near the centre of city. It is built circa 2003 and it has no thermal insulation. The measurements were taken on the first floor, on the external wall with 25cm width.

Fig.8. The location of Building A. & Fig.9. The location of Building B.

3.2 The testing parameters

The measurements were taken on 13th and 14th January, during 8:00pm to 12:00pm. The main reason for doing the measurement during the night is to ensure that the temperature of the wall is not affected by the daytime temperatures.

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°C and the inside temperature was 22°C and on January 14th, the external temperature was 8°C and the indoor temperature was 24°C.)

Then the instruments will be put as the following steps. The indoor air quality meter(Fig.4) is placed in the room where the measurements will be taken. Through this instrument we will have the indoor temperature. The other instruments, Radio handle (Fig.6)and T/C probe head (Fig.7) will be placed outside the room to measure the outdoor temperature. The wall temperature will be measured by triple sensor system(Fig.5)(Fig.10).

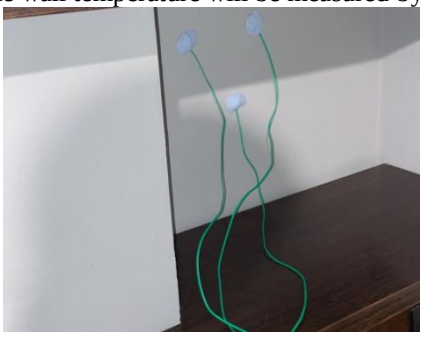

Fig.10. The placement of the triple sensor system on the wall.

3.3 Test results

After the measurements, we will have the results of the rate of heat loss through the wall, that is measured by thermal transmittance, or U-value. It's measured in watts per square meters per Kelvin degree (W/m^2K).

The results are presented in graphic form by using the Testo-Comfort Software. The U-value is visible in both graphicsby the orange line.

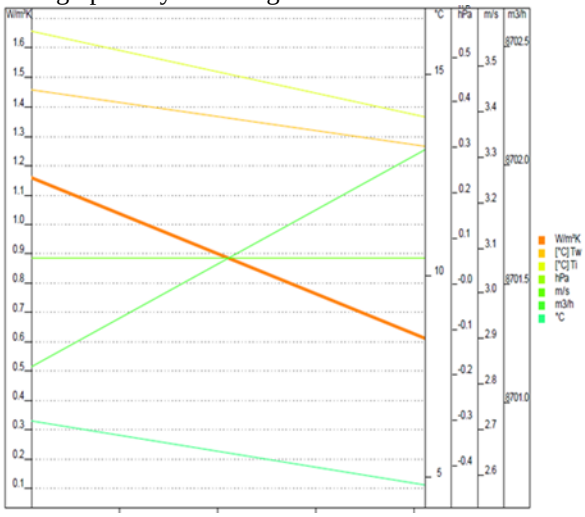

Fig.11. Wall A

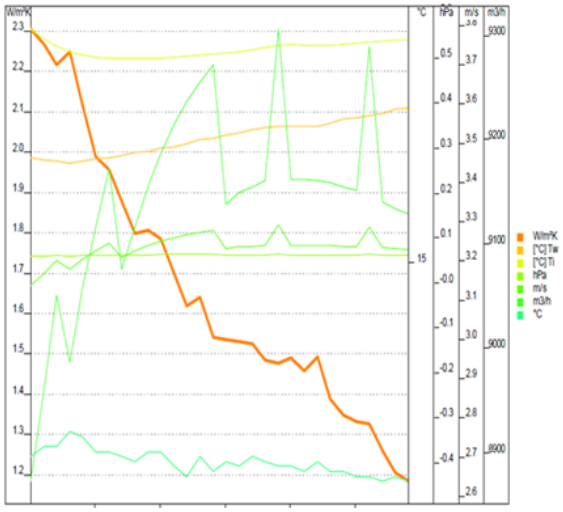

Fig.12.Wall B

4. Conclusion

This paper has presented the compere between a thermal insulated wall and a non-thermal insulated wall, and the rate of heat loss through the respective wall. Based on the measurements results the thermal insulation of the external walls of the constructions, based on the expanded polystyrene as insulating material, is efficient and prevents the heat loss. Graphs above prove that Polystyrene is a great performer as thermal insulator.

On the other hand, the non-insulatedwall allows the heat loss,and this causes not only loss of energy efficiency but also economic damage . So,we must avoid buildings that are non-thermally insulated.

In this way we save energy and move towards a more environmentally friendly construction world!

5. References

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Fig.2 Fig.3 https://omnexus.specialchem.com/selection-guide/expanded-polystyrene-eps-foam-insulation/key-applications

Fig.4-7https://www.testo.com/

Fig.8. Fig.9 Source: Google Map

Fig.10-12 Source: Author