International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

Improving Thermal Efficiency in Prefabricated Buildings with Insulation Materials and Energy-Efficient Glazing Systems

Alma Gjonaj
Department of Engineering, Polis University, Tirana, Albania

Flogerta Krosi, Merita Guri
Department of Engineering, Polis University, Tirana, Albania

Abstract - Large-panel buildings, characteristic of mid-20th-century urban development, continue to constitute a substantial portion of the worldwide building inventory. Their aged infrastructure poses issues to energy efficiency and thermal performance, requiring novel retrofitting solutions. This study examines solutions to tackle these difficulties, emphasizing sustainable treatments such as enhanced insulation materials and energy-efficient glass to improve thermal performance and minimize environmental effects.

The methodology includes a thorough evaluation of the thermal efficiency of large-panel structures via simulation and case analyses. Essential retrofitting measures, such as the implementation of stone wool insulation and the enhancement of windows with energy-efficient glazing systems, are assessed for their effects on energy efficiency.
The results show significant reductions in energy consumption after retrofitting. The study evaluates the impact of various refurbishment interventions on energy performance. Results show that adding insulation (e.g., polystyrene, wool) combined with energy-efficient windows significantly reduces primary energy consumption, improving the building's energy class from G to D. The most effective solution involves double insulation, energy-efficient windows, and terrace + ground insulation, achieving a primary energy consumption of 184.56 kWh/m².
In conclusion, upgrading large-panel buildings with additional insulation and energy-efficient glass significantly enhances energy efficiency and lowers environmental impact. These findings offer significant insights for improving the sustainability of current building stock and promoting sustainable urban growth.

Keywords: ***prefabricated buildings, heat flow, glazing system, construction materials.***

1. INTRODUCTION

Prefabricated structures, especially those built in the mid-20th century, constitute a substantial segment of the worldwide building inventory. Engineered for quick assembly and economic viability, these structures have deteriorated significantly, frequently falling short of contemporary energy efficiency, comfort, and sustainability benchmarks. Improving their energy performance is an urgent task since these buildings significantly contribute to greenhouse gas emissions due to obsolete insulation, poor heating systems, and excessive energy usage. Enhancing their efficiency not only corresponds with environmental objectives but also elevates the quality of life for inhabitants and prolongs the durability of the building.

Refurbishment initiatives concentrate on improving the thermal efficiency of building envelopes, incorporating renewable energy systems, and upgrading heating, ventilation, and air conditioning (HVAC) technology. Essential measures encompass the incorporation of modern insulating materials, the substitution of inefficient windows with high-performance glazing systems, and the use of renewable energy technology such as photovoltaic panels and solar thermal collectors. Structural advancements, like self-supporting exoskeletons, enable the integration of enhancements while maintaining the original integrity of the structures. Implementing these methods can markedly enhance the energy efficiency of large-panel structures, fostering a sustainable urban future.

Heat transfer is of paramount importance in buildings due to its direct impact on energy efficiency, occupant comfort, and structural integrity. Reducing heat loss in the cooler months and increasing heat gain in the warmer months is how effective heat transfer management keeps buildings thermally comfortable all year round. In addition to improving occupant productivity and well-being,

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

this reduces the need for mechanical heating and cooling systems, which saves a substantial amount of energy and lowers operating expenses. Additionally, by avoiding problems like moisture accumulation, thermal stress, and material degradation, managing heat transfer contributes to the longevity and durability of building components. Optimizing heat transfer in buildings is essential for creating sustainable, resilient, and environmentally friendly built environments that meet the evolving needs of occupants while minimizing environmental impact.

Optimizing heat transfer in buildings is vital for achieving zero carbon emissions goals. Buildings' energy usage for lighting, heating, and cooling makes them major contributors to carbon emissions. This footprint can be decreased with better energy efficiency and heat transfer management. Efforts focused on creating zero-carbon buildings focus on efficient design, integrating renewable energy sources, and minimizing total environmental impact. Optimizing heat transmission effectively reduces dependency on fossil fuels, which is consistent with sustainability goals. Additionally, it encourages the preservation of resources and backs larger initiatives to reduce climate change. To achieve zero carbon goals, heat transmission must be optimized to minimize the use of energy and reduce impact on the environment.

2. EVALUATION METHODOLOGY OF THERMAL PERFORMANCE

The examination of the building's thermal performance requires the methodical reenactment of various scenarios concerning thermal layers. All of the scenarios use easily obtained components in Albania from different businesses, together with accurate cost data for careful examination. Based on a comparative analysis using data from research projects in Kamza [1] and Tirana [2], it is evident that windows pose the biggest heat transfer problem. Working with the Alumil company, two different kinds of windows with differing U values and a 30% cost difference have been computationally modeled.

A two-layer approach is used, paying particular attention to the walls, terraces, and ground floor's thermal properties. Stone wool is used in the second layer, while the commonly used polystyrene is used in the first. To maximize insulation for outdoor applications, both layers are extended to a thickness of 10 cm. On the inside, a single layout is used, with a 6 cm stone wall system enhanced by a 1.2 cm plasterboard layer. This all-encompassing strategy seeks to examine and improve the building's thermal dynamics while balancing cost- and efficiency-effectiveness to find the best option for environmentally friendly and energy-efficient building techniques.

For every model, a comprehensive analysis will be carried out with an emphasis on the impact on the thermal insulation capabilities of different materials and the investigation of heat transmission between layers. Based on the conclusions of the models that were studied, the building's overall thermal performance will be measured for each situation. It is noteworthy that this rating does not take into account the building's intermediate floors. In addition, the computation assigns a U-value of 0.4 W/(m2K) to the separation wall between the two existing structures. This methodical methodology guarantees a thorough investigation of the building envelope's thermal behavior, offering precise and pertinent insights into the functionality of various materials and their role in overall thermal insulation.

2.1 Temperatures

With the understanding that thermal performance varies with external conditions, the calculations for heat transmission will be made using the MEEC application, a program commonly employed in Montenegro [3] [4]. Podgorica’s climate was selected for thermal simulations due to its geographical proximity and similar climatic conditions to the study area in Albania. This ensures that the results reflect realistic thermal behavior under comparable environmental conditions. According to the technical report [5], we have an Average annual temperature, of 15.2 ºC, the Highest average summer temperature, of 29.9ºC, the Highest absolute temperature, of 42.2ºC, the Lowest average winter temperature, of 6.7 ºC, the Lowest absolute temperature, of -10.4 ºC. For the city of Podgorica, the temperatures to be calculated are recorded directly in the program. In Podgorica, the average January temperature is 5.0° C, July 25.9° C, while the annual temperature is 15.3° C. Since the average temperature nearly stays the same the higher we drive, we can consider Podgorica.

2.2 Methods of heat transfer

To evaluate heat transfer in the building envelope, the MEEC program was utilized, mirroring the approach used in the case study in the city of Kamza as presented in the paper [1]. The thermal balancing equation (Gain = Losses) underpins the analysis, accounting for variables such as sensible gain, mechanical gain, solar gain, additional heating, ventilation, and evaporative losses. Simplifications were proposed in line with the MEEC initiative.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

Fourier's equation for thermal conduction in brickwork is examined, along with other heat transport modes like conduction, convection, and radiation. The significance of the thermal resistance ("R" value) and thermal conductance coefficient ("U" value) in assessing the insulating properties of materials is discussed. These attributes are crucial for energy-efficient building design, as demonstrated by the overall thermal transmittance and resistance values for building components made of many layers.

2.3 Thermal losses in different elements of the building

Thermal losses in walls

Designing energy-efficient and thermally comfortable buildings requires an understanding of the mechanics underlying heat transmission in building walls. The three main ways that heat is transferred are by convection, which involves the movement of air within wall assemblies and cavities, radiation, which involves heat being emitted and absorbed by surfaces at different temperatures, and conduction, which involves heat moving through solid materials like concrete, brick, or insulation. Every mechanism has a major impact on how well a building envelope performs thermally overall.

Heat transfer through walls under stable conditions involves heat transmission from hot surroundings, heat transfer through the wall, and heat transfer to the surrounding cold surroundings. The total resistance to heat passage through the wall is determined by the resistance of the wall material and the resistances between wall layers and their surroundings. Thermal resistance per unit area measures the temperature differential needed to generate unit heat flow, while conductance per unit area calculates the rate of heat transfer per unit area for a specific temperature differential. Thermal conductivity quantifies heat transfer per unit area for a given temperature difference per unit thickness. Surface resistance, which encompasses conduction, convection, and radiation, is crucial for understanding the interplay of conduction, convection, and radiation in determining overall thermal resistance in walls. These concepts are often handled as constants for ease of use.

Wall thermal resistance, independent of surface resistances, depends primarily on the material properties and thickness. Air leakage can alter this resistance, emphasizing the importance of proper construction and sealing. In solid walls, conduction is the primary method of heat transfer, directly proportional to the temperature difference across surfaces. This resistance is mostly determined by the heat conductivity of the materials that compose the wall. Conduction, convection, and radiation are the three ways that heat is transferred in walls that have spaces, like hollow tile or frame construction. In walls with voids, such as hollow tile or frame construction, heat transfer involves conduction, convection, and radiation. The complexity of these interactions makes it challenging to isolate the predominant mechanism in typical hollow-wall constructions. Due to substantial changes in radiation, closed air spaces within walls, which are affected by construction variations, demonstrate increasing heat transfer with temperature. Understanding these principles is crucial for effective thermal design and insulation strategies in building construction. [6] While walls significantly influence the building's thermal resistance, the floor plays a similarly crucial role, especially in buildings with direct ground contact.

The main method of heat transfer between wall layers is conduction. The transfer of thermal energy through a material or between materials in direct contact because of temperature differences is known as conduction. Heat moves through each layer of the wall from the warmer to the cooler side when there is a temperature gradient. The thermal resistance (R) of each layer in the wall assembly depends on two main factors: the material properties and the thickness of the layer. For calculating thermal resistance (R) for a layer:

$$R = \frac{d}{k} \tag{1}$$

Where R is the thermal resistance of the layer; d is the thickness of the layer, and k is the thermal conductivity of the material composing the layer.

To calculate the overall thermal resistance of the wall assembly, you sum up the thermal resistances of all individual layers. If the wall has n layers, you add the thermal resistances of each layer:

$$\sum_{i=1}^{n} R_i \tag{2}$$

After determining the total thermal resistance of the wall assembly, we can calculate the U-value (thermal transmittance) using the formula:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

$$U = \frac{1}{\sum_{i=1}^{n} R_i} \tag{3}$$

Where U is the U-value or thermal transmittance of the wall assembly and $\sum_{i=1}^{n} R_i$ is the sum of the thermal resistances of all layers in the wall assembly.

The 'n' individual resistances that make up a structure are combined with the inside and outside surface resistances, Rsi and Rse, (m2K/W) to give a total resistance, ΣR, for the element

$$\Sigma R = Rsi + R1 + R2 + \ldots.. + Rn + Rse \; m2K/W \tag{4}$$

The U value is simply the reciprocal of the total resistance, ie 1/ΣR, and then the basic building fabric heat transfer coefficient is Σ(A U) where the area, A (m2) is the area of each element that has a respective thermal transmittance of U (W/m2K).

U-values play a crucial role in determining a building's energy efficiency. Better insulation and less heat transmission are indicated by lower U-values, which promote energy conservation. Low U-values in cold climates reduce heat loss via windows, roofs, and walls, keeping interior rooms warm during the winter. Effective insulation with low U-values keeps extra heat out of the building in hot climates, which lowers energy consumption and the need for air conditioning. Certain U-values for various building components are required by building rules and regulations in many different nations. These rules seek to decrease building energy use, increase energy efficiency, and lessen greenhouse gas emissions. [7] Building floors, particularly those in contact with the ground or subsurface layers, experience unique thermal losses that must be addressed in energy-efficient designs.

Thermal losses in the floors

Regarding the floor, there are three different kinds of losses:

- The first one is the one that enters a perimeter belt and goes straight outside.
- The second is the losses toward the subsurface, where it is anticipated that there will be a water layer.

In this case, the thermal losses are proportional to the difference between the internal and external temperatures, but taking a perimeter strip of the floor next to the external walls or inserted underground, is equal to:

$$S_p = P \times (2 - h) \tag{5}$$

Thermal losses:

$$Q_d = K_e \times S_p \times (t_b - t_j) \quad [W\ or\ kkal/h] \tag{6}$$

Equivalent thermal transmission coefficient

$$K_e = \frac{1}{\frac{1}{k_e} + \frac{2}{\lambda_f}} \tag{7}$$

The third in the perimeter angle's length

The temperature differential between the subsurface and the surface water layer (t=10–15°C) as well as the total floor area, including the section close to the surrounding area, is proportionate to thermal losses to the subsurface:

Thermal losses:

$$Q_P = K_e \times S \times (t_b - t_j) \tag{8}$$

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

Equivalent thermal transmission coefficient

$$K_e = \frac{1}{\frac{1}{k_e} + \frac{1}{C}} \tag{9}$$

Thermal Losses on the Rooftops

The coefficient of thermal transmission for the ceiling and thermal losses are determined using standard formulas, considering the temperature of indoor air near the ceiling and the temperature under the roof. These calculations are based on well-documented recommendations and tables.

From rooftops, the analysis transitions to windows, which often represent the most significant source of heat transfer in large-panel buildings.

Losses in Thermal Bridges

If in a homogeneous structure with thermal resistance Ros, integrated for reasons of building statics or architecture, with greater thermal conductivity, then in this area the heat flow increases, and therefore this area is called "bridge (point) thermal". In the case of prefabricated buildings, the bridge considers the connections of the panels to each other. [7]

Window Energy-Efficient Glazing Systems

According to the study of the thermal performance of large panel buildings in the city of Kamza [1] the most problematic element in the building was the window glazing system. Energy-efficient glazing systems for windows are sophisticated technologies aimed at enhancing the thermal and energy efficiency of structures. These solutions diminish heat transmission, improve interior comfort, and reduce energy usage for heating, cooling, and lighting. They are an essential element in sustainable construction methodologies, particularly in the retrofitting of existing edifices or the design of new energy-efficient constructions.

As given in [11] glass that has a low emissivity coating is referred to as low-E glass. It minimizes heat gain or loss by reflecting long-wave infrared energy (solar heat), hence reducing the U-value and solar heat gain, and enhancing the energy efficiency of the glazing. Due to its aesthetic neutrality and energy efficiency, low-E glass is extensively utilized in residential and commercial structures, with anticipated growth

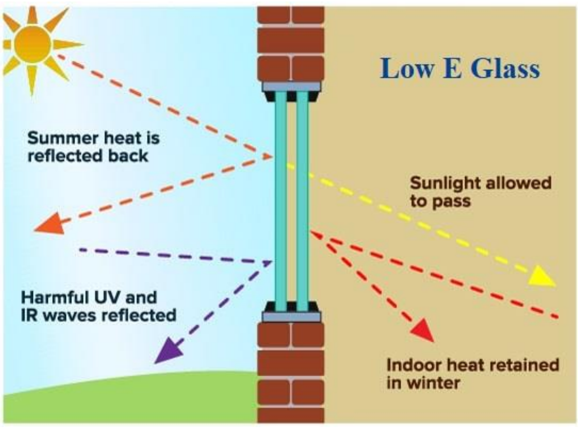


Fig. 1 Low E Glass. [8]

2.4 Thermal materials

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

The increasing emphasis on energy conservation has led to the widespread use of thermal insulation materials in buildings. These materials, which include a combination of substances to retard heat flow by conduction, convection, and radiation, offer numerous benefits. By reducing reliance on heating, ventilation, and air conditioning (HVAC) systems, thermal insulation helps conserve energy and natural resources while extending periods of indoor thermal comfort and reducing noise levels. Various types of insulation, including inorganic, organic, combined, and advanced materials, are available in different forms, such as porous, blanket, rigid, and reflective structures. Inorganic materials like glass wool and stone wool are prevalent due to their low thermal conductivity and cost-effectiveness. Organic materials, derived from natural resources, offer attractiveness, renewability, recyclability, and environmental friendliness. Despite their benefits, some insulation materials may pose health risks, such as skin and lung irritation. Ongoing research and innovation continue to drive the development of sustainable insulation products with lower embodied energy and reduced environmental emissions. [8]

Thermal insulating materials undergo testing according to standards such as EN 12664, EN 12667, EN 12939, ASTM C518, and ASTM C177 to assess their thermal resistance properties. However, due to the diverse thermal properties of insulation materials, there isn't a universal measurement method for determining thermal conductivity. Inorganic materials typically exhibit thermal conductivity values ranging from 0.03 to 0.07 W/(m.K), while organic materials range from 0.02 to 0.055 W/(m.K), and advanced materials boast values lower than 0.01 W/(m.K). Porous materials generally have nominal thermal conductivity ranging from 0.02 to 0.08 W/(m.K), whereas alternative insulation materials derived from natural fibers vary from 0.04 to 0.09 W/(m.K). Conventional materials like mineral wool and foamed polystyrene are favored for thermal energy storage systems due to their durability and affordability. Meanwhile, natural fiber-based insulation materials sourced from agricultural waste, such as coconut and rice straw, are gaining traction in building applications due to their eco-friendly attributes. However, their high water absorption presents a challenge, leading to increased thermal conductivity.

Insulation materials are crucial for reducing heat loss in buildings, as they are designed to have low thermal conductivity, meaning they resist the flow of heat. The effectiveness of an insulation layer, primarily determined by its thermal conductivity (λ-value), significantly impacts the thermal performance of a building envelope. At a microscopic level, various factors such as cell size, fiber arrangement, and gas type influence the apparent thermal conductivity of insulation materials. Achieving the minimum thermal conductivity requires optimizing these factors. Macroscopically, temperature, moisture, density, and aging also affect thermal conductivity. Thus, it remains a key parameter in thermal calculations. Insulation materials play a vital role in improving energy efficiency and reducing greenhouse gas emissions from buildings, impacting both heating and cooling needs as well as health considerations. Heat transfer in these materials occurs predominantly through conduction in the solid material and gas molecules, along with radiation through pores, while convection plays a minor role due to small air bubble sizes. Developing environmentally friendly insulation materials requires a clear understanding of their thermal conductivity properties. [9]

The thermal conductivity of insulation materials is a critical factor influencing heat transfer in building envelopes. Understanding the factors that affect thermal conductivity is essential for effective insulation design. Key factors include operating temperature, moisture content, and density, among others. Research suggests that thermal conductivity typically increases with rising temperature. Studies on both inorganic materials like rock wool, mineral wool, fiberglass, and organic materials such as polystyrene (PS), polyethylene (PE), expanded polystyrene (EPS), and polyurethane (PUR) demonstrate this trend. These studies often describe linear relationships between temperature and thermal conductivity coefficients. Empirical observations and experimental investigations confirm the temperature dependency of thermal conductivity, highlighting its importance in insulation performance. [10]

3. SITE VISIT

The study focused on three areas in Tirana: "Alidemi," "21 Dhjetori," and "Technological School." Although the overall architectural style was the same, there were variations in each zone. The neighborhood selected for the December 21 case study was distinct from the others due to the presence of six-story structures.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026


a) b)


c) d)

Fig. 2 Drone photography for the 3 areas a), b) 21 Dhjetori area c) Alidemi d) Technological School

Residents have implemented various actions regarding the subjects of investigation, having been there for over fifty years. The on-site study revealed that the air conditioner serves as the primary heating system. Remarkably, only a single object has been insulated in the study area—a choice made solely at the proprietors' discretion without expert assistance. This building features a notable situation in which the first-floor panel has been dismantled, and the living room is currently utilized as a small commercial space. This alteration, which should not have received approval, jeopardizes the panel's capacity to bear weight. Stairs have been constructed to provide the company with street-level access as part of the structural modifications. The resident modifications in this structure are significant; one such intervention is the enclosure of balconies for inside utilization. The subsequent table delineates the panels that initially had balconies and details the specific modifications implemented for each. A prevalent remark regarding this structure is that nearly all gutters lack drainage connections. Consequently, water from these gutters discharges directly onto the pavement and highway. This unregulated water flow not only presents potential environmental hazards but also facilitates the accumulation of mold layers in these areas and on the walls traversed by the gutters.



a) b) c)

Fig. 3 a) air-conditioning heating, b) the creation of Mold from moisture, c) balcony filing,

4. CASE STUDY

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

The case study involves a five-story prefabricated residential building in Tirana, Albania, built in the 1970s. The structure features concrete panels with minimal insulation, typical of large-panel buildings in the region. The building is located in a Mediterranean climate, characterized by hot summers and mild winters, making energy efficiency improvements critical. The specific building analyzed in this study is situated in the "21 Dhjetori" neighborhood of Tirana, the capital city of Albania.

a) b)

Fig. 4 a) The plan of the neighbourhood; source Co-Plan b) Drone photo of the building studied: source Co-Plan

Only a single block from section 2.1 was included in the analysis, with the drawings sourced from [12]

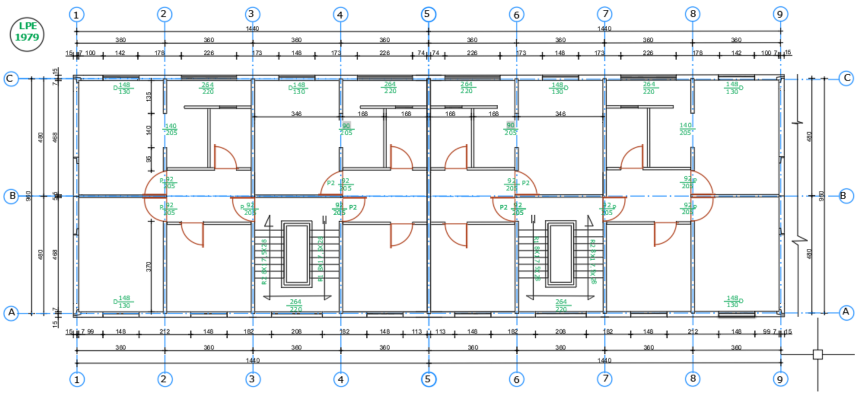


Fig. 5. a) The plan of the building.

The figures presented above are copies of the original data collected by AQTN (CENTRAL TECHNICAL BUILDING ARCHIVE) and are recreated based on the site visit. [12]

The details of the panel and the foundation are derived from research conducted in the city of Kamza in 2023 for the thermal performance of those buildings. [1]

Materials used for different elements and the characteristics of the materials are taken from the technical design code and the methodical guide for calculating the seismicity of building constructions. [13] Concrete class C16/20 unit weight $\gamma = 2400 kg/cm^2$. Foam concrete unit weight $\gamma = 500 kg/cm^2$. Cement plaster with a unit weight $\gamma = 2000 kg/cm^2$, Waterproofing with a unit weight $\gamma = 1200 kg/cm^2$, Gravel $\gamma = 1200 kg/cm^2$

Materials proposed

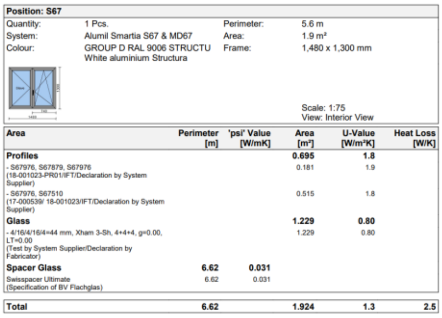
- Windows

We advocate for the utilization of the Alumil company's advanced window systems, namely the "Hinged Insulated System SMARTIA S67" and "Hinged Insulated System SMARTIA S77," as innovative materials for windows. Both systems demonstrate superior thermal performance characteristics, contributing to enhanced energy efficiency. However, it is pertinent to note that the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

SMARTIA S77 variant incurs a 30% higher cost in comparison to the SMARTIA S67. This cost disparity must be carefully considered in the decision-making process, weighing the heightened thermal benefits against the associated financial implications. The nuanced comparison between these two systems provides a comprehensive evaluation, enabling stakeholders to make informed choices based on both technical merits and economic considerations within the context of sustainable building solutions. [14] [14]

The thermal transmission coefficients UW were determined for single windows according to EN ISO 10077-1:2017. The calculation of the Uw-values of windows as well as the UD-values of doors and the Ucw-values of curtain walls was carried out with the software 25/01/2024 (U-value calculation version 1.1.0.0) according to EN ISO 10077-1:2017-07 and EN ISO 12631:2017-07. The calculation method of the calculation program was checked by ift Rosenheim for plausibility according to ift guideline WA-05/2:2012-08. The input data for the present U-value calculation was not checked by Ift Rosenheim. Relevant proof of the basic data of the calculation must be used as applicable documentation. [15]



Position: S67			
Quantity:	1 Pcs.	Perimeter:	5.6 m
System:	Alumil Smartia S67 & MD67	Area:	1.9 m²
Colour:	GROUP D RAL 9006 STRUCTU White aluminium Structura	Frame:	1,480 x 1,300 mm
			Scale: 1:75 View: Interior View

Area	Perimeter [m]	'psi' Value [W/mK]	Area [m²]	U-Value [W/m²K]	Heat Loss [W/K]
Profiles			**0.695**	**1.8**	
- S67976, S67879, S67976 (18-001023-PR01/IFT/Declaration by System Supplier)			0.181	1.9	
- S67976, S67510 (17-000539/ 18-001023/IFT/Declaration by System Supplier)			0.515	1.8	
Glass			**1.229**	**0.80**	
- 4/16/4/16/4=44 mm, Xham 3-Sh, 4+4+4, g=0.00, LT=0.00 (Test by System Supplier/Declaration by Fabricator)			1.229	0.80	
Spacer Glass	**6.62**	**0.031**			
Swisspacer Ultimate (Specification of BV Flachglas)	6.62	0.031			
Total	**6.62**		**1.924**	**1.3**	**2.5**

Fig. 6 a) Technical value of the S67 system b) Cross-section of the S67 system

- Foundation

Numerous studies on the seismic behaviour of structures with prefabricated panels made of reinforced concrete have revealed significant structural difficulties. More specifically, problems have been identified with the connection of these panels and how they are connected to the foundations. The identified deficiencies highlight possible weaknesses in the overall structural stability of these types of structures in the event of an earthquake. To reduce hazards, the panels' connections to one another and the core elements must be carefully considered. [16]

Three new layers have been added to the existing ones—a waterproofing layer, a polystyrene thermal insulation layer, and a concrete layer—to prevent structural modifications to the building's floor layers. The floor layers were not considered when assessing the building's thermal performance.

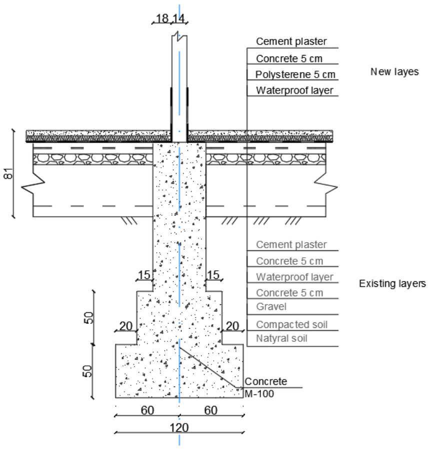


Fig. 7 Foundation proposed intervention.

- Building roof

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

The existing waterproofing and thermal insulation layers on dormant terraces—aside from those in the "21 December" area with floor additions—will be removed. To replace them, the old layers must be removed and replaced with new ones that have better thermal insulation qualities. This focused intervention is to modernize the terrace structures, with an emphasis on applying cutting-edge insulation materials to improve thermal performance.

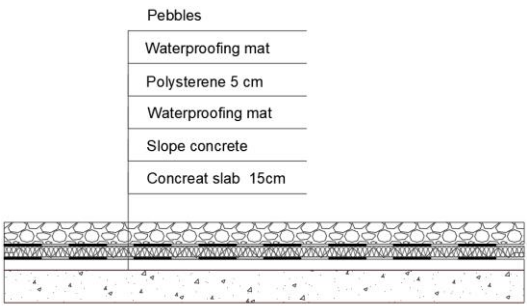


Fig. 8 The proposed intervention on the roof

- Wall panels

For the wall will be tester the polystyrene layers outside the panels case 1, stone wall in the inside, even both outside and inside layers double insulation case 3. Each of these cases will be combined with the new tarrace layesr and with new ground layers.

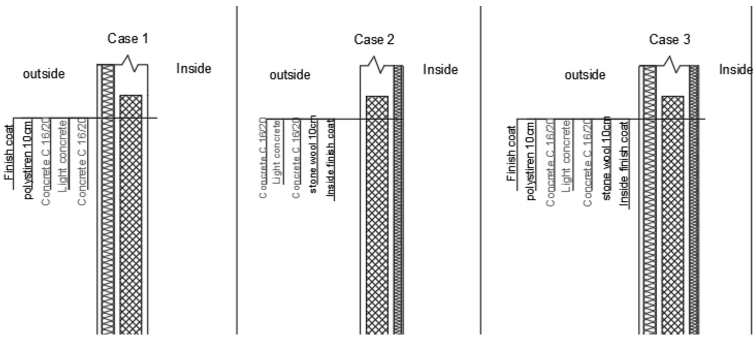


Fig. 9 a) The intervention on the foundation, b) the intervention on the ro, c) 4 different case study

5. Results

A can be seen in the photo below the energy transmitted in the existing window is 149.36 (kWh/m^{2}mth) and in the new system is 39.47(kWh/m^{2}mth)

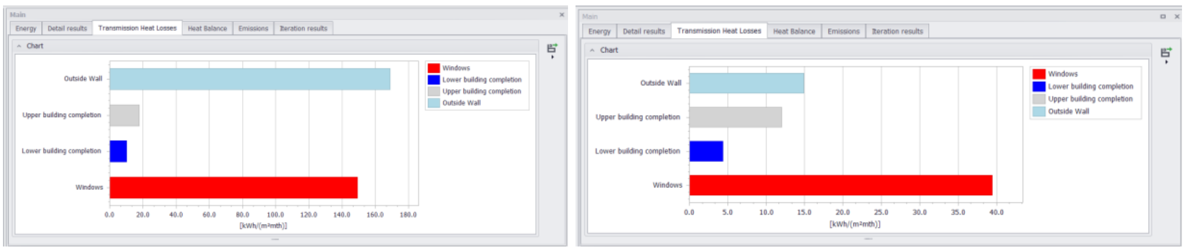


Fig. 10 a) Heat transition losses without on existing building, b) Heat transition losses without on existing building

The result of the other case study are presented in the table below:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

Table 1 the result for different case study.

Main intervention	Additional change	National Building	Primary energy	Differences	Class
no changes	no changes	212.48	615.77	289.8	G
Vertical layers	Panel insulation	212.48	517.67	237.9	G
Horizontal Layers +	The terrace	212.48	601.3	283	G
	The ground	212.48	302.22	283.4	G
	Terrace + Ground	212.48	587.75	276.6	G
Windows +	no changes	212.48	335.15	157.7	F
	The terrace	212.48	321.24	151.2	F
	The ground	212.48	322.44	151.8	F
	Terrace + Ground	212.48	308.6	145.2	F
10cm outside polystyrene + Windows +	no changes	212.48	217.75	102.5	E
	The terrace	212.48	204.51	96.2	D
	The ground	212.48	205.78	96.8	D
	Terrace + Ground	212.48	183.45	86.4	D
10 wool inside layers +Windows +	no changes	212.48	217.75	102.5	E
	The terrace	212.48	204.51	96.2	D
	The ground	212.48	205.78	96.8	D
	Terrace + Ground	212.48	183.45	86.4	D
Double Insulation + windows+	no changes	212.48	206.72	97.3	D
	The terrace	212.48	193.58	91.1	D
	The ground	212.48	197.57	90.8	D
	Terrace + Ground	212.48	184.56	84.8	D

6. CONCLUSION

Interventions in the foundation of large-panel buildings are particularly sensitive due to their structural configuration. The potential risk of compromising the horizontal joints that connect the panels to the foundation underscores the need for careful planning and execution. Adding additional insulation layers to existing ones may reduce floor height, incur high costs, and yield only marginal improvements in energy efficiency.

Roof renovations, while not significantly enhancing energy performance, are recommended for their dual benefit of incorporating waterproofing layers, thereby addressing both energy and maintenance concerns.

Applying thermal insulation to facade panels demonstrates a notable impact on energy efficiency, resulting in significant reductions in energy transmission and an improvement in the energy performance classification.

Windows, as a dominant element of the facade, plays a critical role in energy performance. Upgrading windows can directly enhance the energy efficiency classification by up to two levels, making this intervention one of the most effective measures for improving overall building performance.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

7. REFERENCES

[1] F. K. K. X. Merita Guri, "STUDY OF THERMAL PERFORMANCE OF PREFABRICATED LARGE PANEL BUILDINGS," in *2nd Croatian Conference on Earthquake Engineering - 2CroCEE*, Croatia, 2023.

[2] G. ISLAMI, "Përmirësimi i performancës energjetike në," *Punim Disertacioni,* 2016.

[3] E. E. H. K. K. W. S. Budde, "Technical Manual MEEC—Montenegrin Energy Efficiency Certification," Montenegro, 2020.

[4] E. E. H. K. K. W. S. Budde, "Technical Manual MEEC—Montenegrin Energy Efficiency Certification,," Montenegro, 2020.

[5] F. VEIZAJ, "RAPORTI TEKNIK," DREJTORIA E PERGJITHSHME E PUNEVE PUBLIKE, Tirane, 2018.

[6] J. L. F. M. S. Van Dusen, "Heat transfer through building wall," Washingtone, 1930.

[7] A. S. R. A. L. Voshtina, TERMOTEKNIKA, NGROHJA DHE ARJI I KONDICIONUAR, Tiranë: Perlat Voshtina, 2009.

[8] E. Giama, "U-Value: A key role parameter for sustainable buildings," *ournal of Sustainable Architecture and Civil Engineering,* vol. 16, no. Vol. 16 No. 3 (2016), 2016.

[9] N. Yüksel, "The Review of Some Commonly Used Methods and Techniques to Measure the Thermal Conductivity of Insulation Materials," 2026. [Online]. Available: https://www.intechopen.com/chapters/51497. [Accessed 28 01 2024].

[10] F. D.-M. A. M. C.-L. M. C.-L. C. A. C. Andres, "Uncertainty in the thermal conductivity of insulation materials," *Energy and Buildings,* vol. 42, no. 11, pp. 2159-2168, 2010.

[11] Jinjing (Group) Co, "G-Crystal," 2023. [Online]. Available: https://www.jinjing-glass.com/energy-efficient-low-e-coated-glass-product/?gad_source=1&gclid=CjwKCAiA65m7BhAwEiwAAgu4JD9KgCDMkZBk6wrbn-2XXZhOAFvzzEQJIhEr2XlZQ1uLgzhDQNXkPRoCW_MQAvD_BwE.

[12] AQTN, "ARKIVI QËNDROR TEKNIK I NDËRTIMIT," [Online]. Available: https://www.aqtn.gov.al/. [Accessed 26 01 2023].

[13] A. E. S. &. M. E. N. "UDHEZUES METODIK PER LLOGARITJEN NE SIZMICITET TE KONSTRUKSIONEVE NDERTIMORE," Tirane, 1990.

[14] Alumil, "Sistem Me hapje I Izoluar SMARTIA S67," [Online]. Available: https://www.alumil.com/albania/homeowners/products/all-products/hinged-insulated-system-smartia-s67. [Accessed 15 12 2023].

[15] I. 10077-1:2017, "Thermal performance of windows, doors and shutters. Calculation of thermal transmittance General," Geneva, Switzerland, 2017.

[16] Merita Guri, Svetlana Brzev, Diana Lluka, "Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake," *Taylor & Frances,* 2022.