International
Journal
Of Advanced Research in Engineering & Management (IJAREM)
ISSN: 2456-2033 || PP. 07-12

Thermal Performance of External Walls, Case Study Tirana, Albania

Marvin Basha[1], Xhordi Dema[2], Geraldo Zyko[3], Klodjan Xhexhi[4]
[1]*(Structural Engineering/Polis University, Albania)*
[2]*(Structural Engineering/Polis University, Albania)*
[3]*(Structural Engineering/Polis University, Albania)*
[4]*(Architecture & Design/Polis University, Albania)*

Abstract: The need to design and build according to the resident's demands is the best possible option, in today's economic market. Nowadays, buildings that ensure a good thermal performance is increasing. This article compares the thermal transmittance coefficient (U-value) between a wall with a simple composition of bricks, plaster and graffito without thermal insulation and a wall composed of stone wool, anti-vapors membrane, air gap and terracotta tiles (ventilated façade). This comparison explains the thermal benefits and the best ways to increase the thermal performance of a building, in a particular case of Polis University, Tirana, Albania. The results and conclusions drawn from this article are factual indicators with concrete values that professionals should take into consideration since in the initial stage of design. Choosing the best layers for a façade may result in the creation of a comfortable indoor thermal comfort for the inhabitance in a micro perspective. A good thermal insulation improves the building's thermal balance and contributes decisively to the thermal comfort of the occupants, which means a considerable reduction in heating and cooling loads, in order to increase the building's energy efficiency. The measurements of this comparative analysis will be done by using a specific instrument such as Testo 435-2. Atmospheric conditions will also be considered during the measurements, respectively for internal and external environments.
Keywords: comparison, economy,thermal insulations, U-value measurements, ventilated façade, wall.

Introduction:

The application of the technology of ventilated facades in Albania starts around 2010 up to today and is in continuous progress. One of the first cases in the Albania context is the facade of Polis University building located in the city of Tirana.

The majority of developed nations are now promoting green solutions, such as reducing energy use and promoting renewable energy sources, as a result of the growing abuse of the environment. The Nordic countries were the pioneers in this trend, applying renewable resources above 50% of the total amount of energy production. In accordance with the European Green Deal, the continent of Europe should be entirely climate-neutral by the year 2050 [1].

A key component of sustainable construction is the façade of a building. These parts should insulate the building from extreme weather condition, cold, heat, sunlight, precipitation, and wind, representing the first barrier with the outside environment.

Due to their capacity to reduce cooling and heating loads, their adaptability, and their simplicity of installation, Open Joint Ventilated Facades (OJVF) have recently gained a lot of popularity in both new and renovated structures. This construction method known as OJVF consists of a coating formed of opaque slabs separated by open joints on the outside, an air cavity inside, and a mass wall with insulation on the outside. In contrast to conventional ventilated facades, radiation causes a ventilation flow in the cavity. The fundamental distinction from traditional ventilated façades is the inhomogeneous rate of air circulation along the air cavity, which allows air to enter and exit the open cavity through the joints [2]. The adoption of such systems in numerous building energy retrofit projects is being encouraged by recent advancements in European building criteria regarding the energy efficiency of structures. The conception of external cladding with various materials, structures, textures, or colors is possible with ventilated facades. From the outside, they appear to be composed of an outer layer (referred to as external cladding) attached to the structure with substructures and connectors. Between the insulator and the metal panels, there's a gap of air space. The manufacturer often produces the type of exterior cladding assembly and the substructure to calculate the surface area of the air cavity. Open-joint ventilated facades and closed-joint ventilated facades are the two types of ventilated facades that are distinguished by technical considerations [4]. A typical facade is made up of an outside finish (such as brick veneer, stone or tiles applied over a half-brick wall, etc.), a closed air cavity measuring 5 to 10 cm, an insulation layer applied over perforated brick or concrete blocks, and an inner finish (gypsum layer). The outer coating is frontally fastened to the floor slab in such a way that the thermal bridge is disrupted theoretically. Hence, the air chamber height is almost equal to floor height. Sometimes the closed air chamber is left out or is insulated instead. With a combined conduction coefficient (CC), the thermal behavior of the facade in these circumstances can be easily estimated.

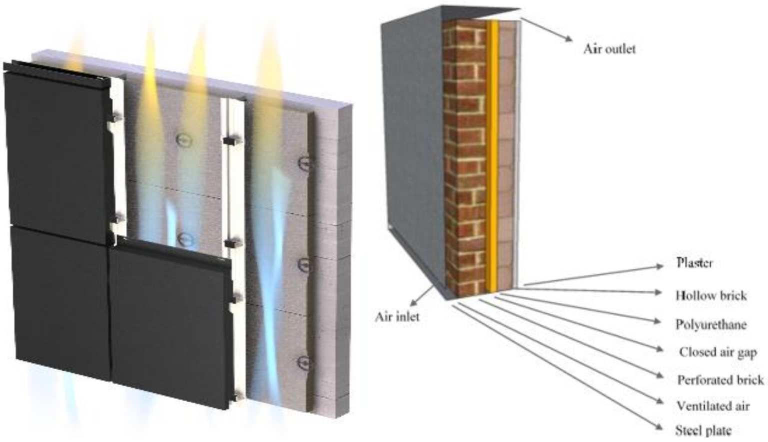


Figure 1. A. Ventilated façade [3]; B. Ventilated facades, wall composition [5]

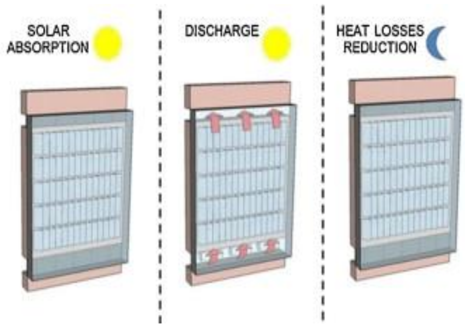


Figure.2 Air circulation [6]

Methodology:

Location of the building

The coordinates of the building are: 41°21'10.7"N 19°45'01.5"E. In both cases, the measurements were done in the same orientation (east) and it was used the same instrument Testo 435-2. The first collected data consists of measuring the U-value (coefficient of thermal transmission) in the ventilated façade. The measurements were done on February 8, 2023. on the first floor of the same building. The measuring process started at 14.00 PM and lasted until 15.00 PM. Outside temperature during measurements was 8.1 degrees Celsius. During the measuring time, 120 measurements were taken, respectively one measurement every 30 seconds.

The second measurements were performed in the same way as the first measurements in the same orientation. The starting time of the second measurement registers 13:41PM of the next day. The measurements ended at 14:41PM.

Both, measurements were carried out in the same building on the different location of the eastern facade equipped with different wall composition.

Figure 3. A. Locating of the building, source: Google earth; B. Polis University eastern facade [8]

Device specification:

Description: This instrument used (Testo 435-2) is a multifunctional professional device which perform different types of tests. The instrument is equipped with three integrated sensors that measures the temperature of the indoor air, the temperature of the wall surface and the temperature of the outdoor air. Name: Testo 435-2 Serial: 60669435

Internal Sensor 1

Description: This sensor is used for measuring thetemperature of the wall surface. It is placed on the inside wall in the form of equilateral triangles with a distance of about 15 cm from one measuring point to another.

Internal Sensor 2

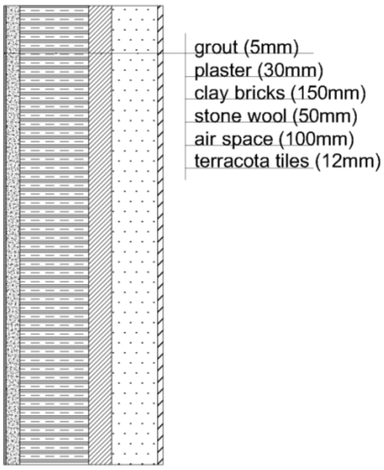
This sensor measures the indoor air temperature and it is localized next to the main device.

External Wireless Sensor 3

Description: This sensor measures the temperature of the outside air. Transmits data wirelessly to the main device.

Figure 4. A. Testo 435-2 measurement device during first measurements. B. Internal sensors C. External wireless sensor; source: authors

Figure 5. A. Testo 435-2 measurement device during second measurements. B. Internal sensors
C. Position of external wireless sensor; source: author



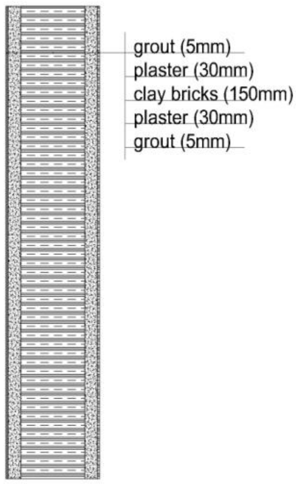


Figure 6. Ventilated façade composition

Figure 7. Standard wall composition

Chart.1 Ventilated façade U-value measurements results, source: authors

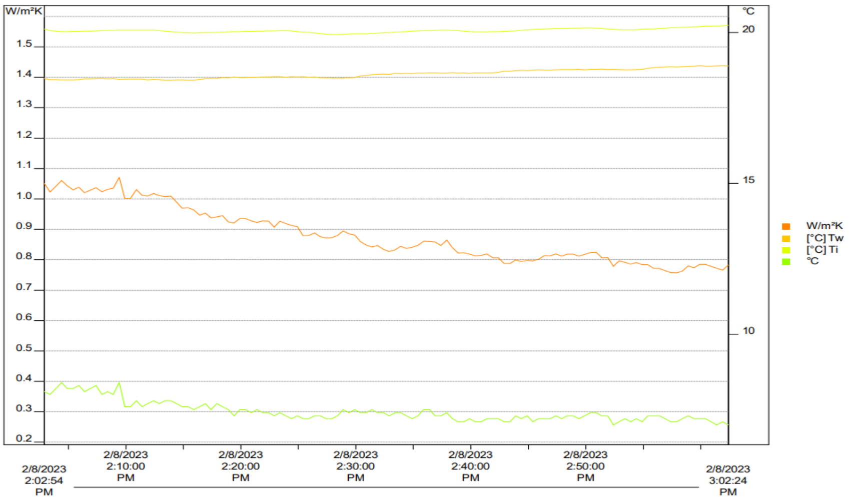


Table.1 Ventilated façade measurements results, source: authors

	Min.value	Max. value	Mean Value	Std.deviation
C: 1 W/m²K	0.757 (2/8/2023 2:57:54 PM)	1.070 (2/8/2023 2:09:24 PM)	0.880	0.090
C: 2 [°C] Tw	18.4 (2/8/2023 2:15:54 PM)	18.9 (2/8/2023 3:01:54 PM)	18.6	0.1
C:3 [°C] Ti	19.9 (2/8/2023 2:28:24 PM)	20.2 (2/8/2023 3:02:24 PM)	20.1	0.1
C: 4 °C	7.0 (2/8/2023 2:52:24 PM)	8.4 (2/8/2023 2:04:24 PM)	7.4	0.3

The measurements show a relatively balanced U-value parameter with a mean value of 0.880 W/m2Kas seen in Table 1.The difference of outdoor and indoor air temperature was 11.2 °C, which is a very close value related to the optimal value of 15°C according to the device manual instructions. Regardless to the low mean value of U-value parameter obtained during measurements,the wall thermal performance is still week. Its optimal value according to the Albanian National Regulation of Building Thermal Performance is 0.4 W/m2K [7].

Chart.2 Standard wall U-value measurements results, source: authors

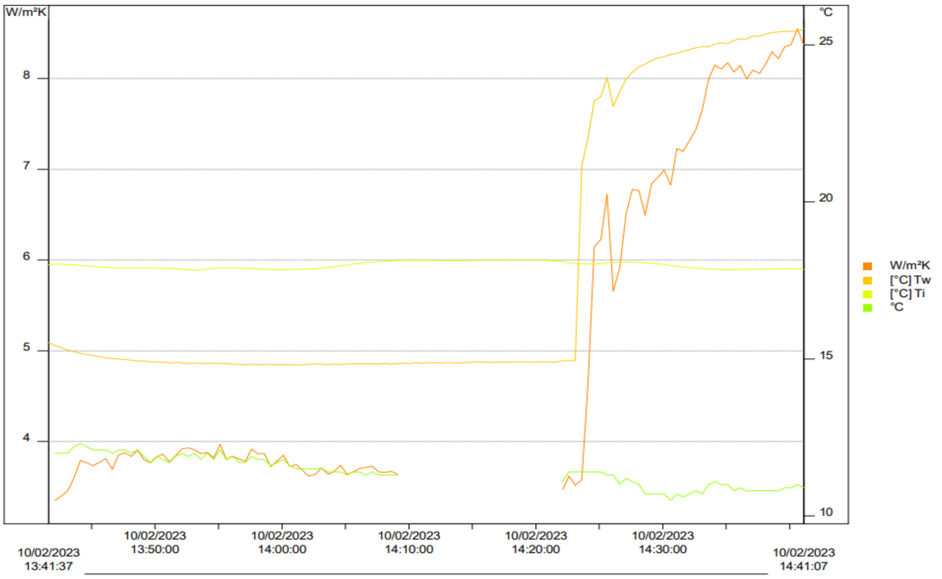


Table.2 Standard wall measurements results, source: authors

	Min.value	Max. value	Mean Value	Std.deviation
C: 1 W/m²K	3.352 (10/02/2023 13:42:07)	8.546 (10/02/2023 14:40:37)	5.085	1.839
C: 2 [°C] Tw	14.8 (10/02/2023 14:01:07)	25.5 (10/02/2023 14:41:07)	17.8	4.4
C:3 [°C] Ti	17.8 (10/02/2023 13:53:07)	18.2 (10/02/2023 14:18:37)	18.0	0.1
C: 4 °C	10.5 (10/02/2023 14:30:07)	12.3 (10/02/2023 13:44:07)	11.4	0.5

The data obtained showed a nonlinear U-value parameter, which means that during the process there were undermine some miscalculations by the instrument. The mean U-value measured was 5.085 W/m2K(as seen in Table 2), which is very high. Furthermore, it is going to be considered just the almost linear data of the U-value measurements during 13.50 up to 14.20 o'clock. The mean value between this time frame is approximately 3.7W/m^{2}K. This value is very poor considering the Albanian National Regulation of Building Thermal Performance.

Conclusion:

Based on the measurements carried out, it is concluded that the wall equipped with the ventilated facade composition has a lower coefficient of thermal transmittance than the standard wall. Respectively, ventilated façade had a mean U-value of 0.88 W/m^{2}K and the standard wall had a mean U-value of 3.7 W/m^{2}K. The measurements performed on the standard wall turned out to be exaggerated due to unsuitable conditions during testing. As a result, the ventilated facade plays a crucial role in building thermal performance, which means a higher building energy efficiency and therefore lower heating and cooling loads.

References

[1]. Schabowicz, K; Zawiślak, L. (2021); Efficiency of ventilated facades in terms of airflow in the air gap. DOI:10.2478/sgem-2021-0014
[2]. Sanjuan, C; Enríquez, R; M. Nuria Sanchez; M.R. Heras. (2012); Experimental PIV Techniques Applied to the Analysis of Natural Convection in Open Joint Ventilated Facades. DOI:10.1016/j.egypro.2012.11.134
[3]. https://stacbond.com/us/ventilated-facade/
[4]. Schabowicz, K; Zawiślak, L. (2020); Numerical Comparison of Thermal Behaviour Between Ventilated Facades. DOI:10.2478/sgem-2019-0044
[5]. Installing Opaque Ventilated Facades for Energy Saving in Old Buildings
[6]. https://ars.els-cdn.com/content/image/1-s2.0-S037877881200535X-fx1.jpg
[7]. Xhexhi, K. (2023) Ecovillages and Ecocities. Bioclimatic Applications from Tirana, Albania. Springer Nature Switzerland AG; ISBN: 978-3-031-20961-1; DOI: 10.1007/978-3-031-20959-8
[8]. http://emegroup.al/index.php?route=product/product&product_id=114