Improvement of the thermal comfort in the building by optimizing the natural ventilation system

Hajji Amine, ERAZA Najoua, Laaroussi Najma, Ouakarrouch Mohamed, Garoum Mohammed, Rhachi Mohammed

Mohammed V University in Rabat, Higher School of Technology-Salé

Materials, Energy, and Acoustics Team (MEAT) Salé, Morocco

Abstract

Thermal comfort and energy conservation in buildings are essential to constructing and managing sustainable and energy efficient buildings. Thermal comfort refers to the temperature, humidity, and airflow conditions inside a building that are optimized for occupant comfort. Buildings should be designed to maintain a comfortable and constant indoor temperature, regardless of the season, using appropriate heating, ventilation, and air conditioning systems. To balance thermal comfort and energy conservation, the building should be designed to maximize energy efficiency while maintaining adequate thermal comfort levels for occupants; This can include using temperature and ventilation control systems to optimize energy use and designing buildings to maximize daylighting and natural ventilation. This study focuses on the integration of a passive ventilation system through the use of parietodynamic windows. Several simulations were performed using Designbuilder software to evaluate the comfort level and potential energy savings offered by using parietodynamic windows. The results of the simulations showed that this solution provides a satisfactory level of comfort with a maximum value of the PMV index of -0.7 without the need for an HVAC system. This solution also allowed us to reduce the annual heating consumption of the building by up to 12%.

Research Objectives

- Using a passive heating system as an efficient and sustainable solution to reduce building energy consumption.
- Reduces heating costs and improves thermal comfort by using sun's natural and convection.
- Studying the energy performance of a tertiary building with and without the addition of parietodynamic effect windows.

Methodology

In the context of this research work, we have chosen as a case study a tertiary building of motel type located in the city of Ifrane in Morocco. Ifrane was chosen because it represents the city with the coldest climate during the winter season on a national scale, making it possible to evaluate the passive heating system under the most unfavorable conditions.

Several simulations have been conducted through the software designbuilder to assess the potential energy savings that offer the use of parietodynamic effect windows.

The building object of the present study is a motel, with a total area of 239.12m2. The main facade of the building is oriented north. January 04 was chosen to compare the simulation results since it represents the coldest day of the year in the city of Ifrane. Moreover, room No. 4 was chosen to evaluate the impact of each scenario

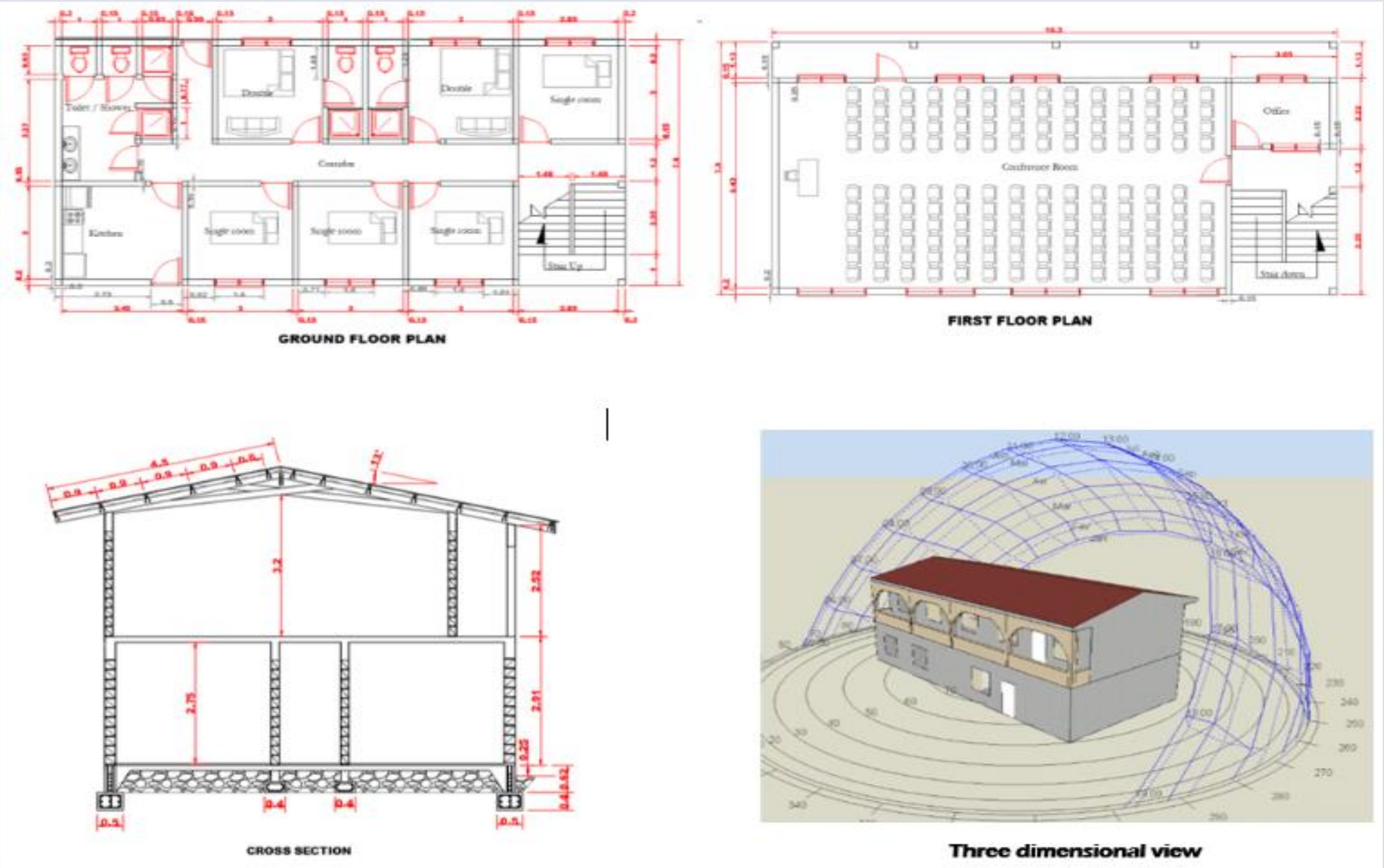

Fig1. two- and three-dimensional building plans

TABLE 1, COMPOSITION OF OPAQUE WALLS

Type of wall	Exterior wall	ground floor	internal floor	pitched roof
Wall composition	Mortar	Parquet flooring	Mortar	Gypsum Plasterboard
	Brick 6H	Extruded Polystyrene	hollow bricks	Vapor barrier
	Extruded Polystyrene	sloping shape	Béton armé	rock wool
	Air layer	concrete slab	sloping shape	Wooden frame
	Brick 8H	sand	Parquet flooring	Rain screen
	Mortar	Stones		Roof tiles
Heat transmission coefficient U (W/m2.k)	0.359	0.365	1.479	0.526
U_{MTCR} Value (W/m2.k)	0.6	0.8	NE	0.55

TABLE 2 COMPOSITION OF BAY WINDOWS

Type of windows	Double glazed 4/20/4
U-value (W/m2.k) for a window area of 1,96m2	2.567
U-value (W/m2.k) for a window area of 2,8 m2	2.580
U MTCR value (W/m2.k)	3.3
Fs	0.651

❖ **Window concept with parietodynamic effect**

The concept of the window with parietodynamic effect consists in replacing the conventional double and triple-glazed windows with windows developed which ensures the ventilation of the zone, and this, by the circulation of the air through the air gap.

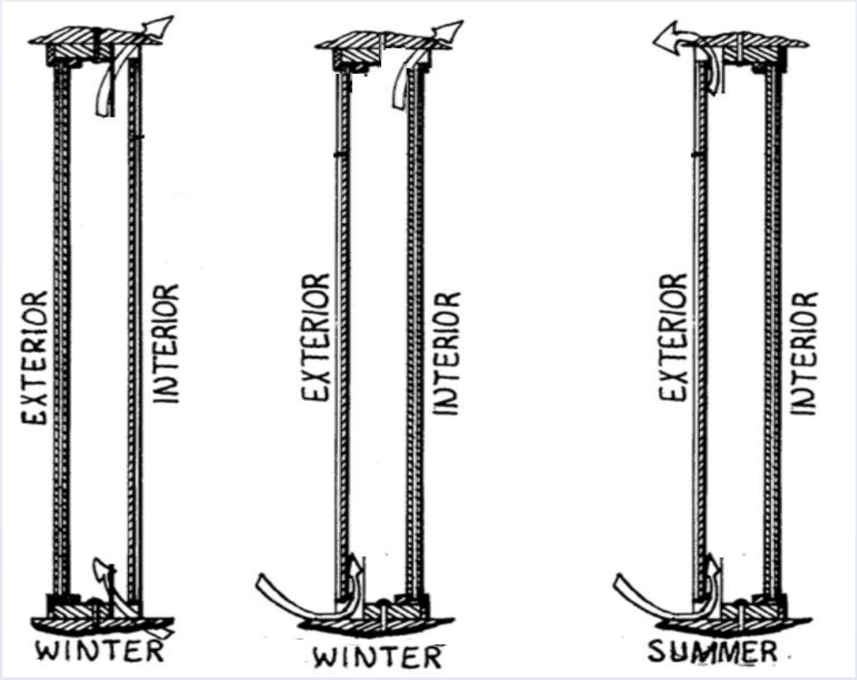

Fig. 2. the operating modes of a parietodynamic window

Results

According to the results, we could see that in the case of parietodynamic windows with a source of indoor airflow, an ideal indoor temperature of between 20 and 23 °C was recorded, similar to that of an HVAC system, with very high PMV values that slightly exceed the ISO 7730 standard with values not exceeding -0.81.

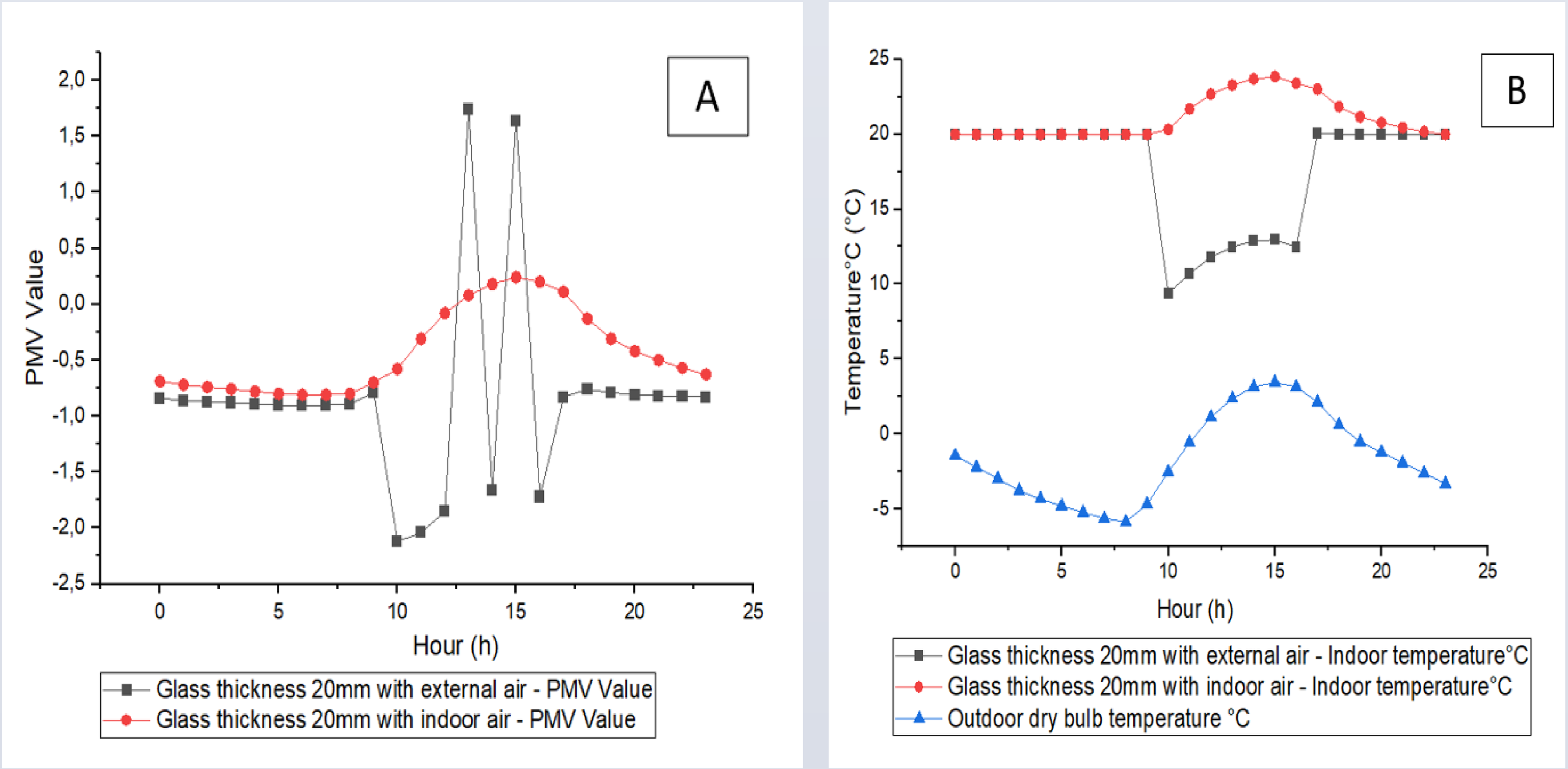

Fig.3. A:PMV value variation for different scenarios / B: Indoor temperature variation for different scenarios

TABLE 2.Annual heating and cooling requirements in the building for the different scenarios studied

	Annual heating and air conditioning requirements (kWh/m2/year)
HVAC system only	45,17
Glass thickness 20mm with external air	58,16
Glass thickness 20mm with indoor air	33,72
MTCR value	34,00

Conclusion

This work presents a study on the integration of parietodynamic windows as a passive heating solution during the winter season; the results of this study allowed us to deduce that:

- The use of parietodynamic effect windows with a source of internal airflow reduced the heating needs of the studied building by 24%, from 45.17 to 33.72 kWh/m2/year.
- The increase in the thickness of the air space for the case of a parietodynamic window with an internal airflow source can further increase the interior temperature of the area; This was felt in the value of the reduced PMV index, which recorded very acceptable values in the order of -0.81, which slightly exceeds the standard iso 7730.
- The use of windows with parietodynamic effects with a source of external airflow has not given satisfactory results for the case of our building..