CIVIL AND ENVIRONMENTAL ENGINEERING REPORTS

E-ISSN 2450-8594

CEER 2023; 33 (3): 0050-0062
DOI: 10.59440/ceer/175465
Original Research Article

THE PORCH AND ITS INTERACTION WITH BUILDING DESIGN IN ARID ZONES

Belkacem BERGHOUT[1], Walid BERGHOUT[2], Imene BERGHOUT[3]
[1] Institute of Applied Science and Technology (ISTA), Hygiene, Safety and Environment Department, University 20 August 1955 Skikda, Algéria
[2] Quebec infrastructure society, Édifice Hectore-Fabre, 525, boulevard René Lévesque Est, 5 -ème étage Québec, G1R 5S9 Canada
[3] Higher national school of renewable energies, environment and sustainable development /Batna, Algeria

Abstract

Improving the energy performance of buildings has thus become a major challenge, as the building sector is now one of the main sources of energy consumption and one of the main contributors to greenhouse gas emissions. Faced with these alarming challenges, current building design in the north is based on minimizing heat loss. However, this logic is not necessarily the most relevant in southern countries, characterized by excessive heat and insufficient, variable rainfall. The best way to achieve this is through sustainable design, with its intrinsic, energy-saving qualities, exploited by effective modeling. This article focuses on ideas and innovations that are helping to overcome these challenges. The results of introducing a porch into building design represent best practice in arid zones and beyond in terms of how it is thermally insulated. This has resulted in a significant reduction in thermal load in the energy ratio of up to 53.55%. This latest research aims to provide construction professionals with concrete examples of the design process, its technical feasibility, optimization and digitization based on climatic data from the arid zone.

Keywords: arid zones, Biskra, design processes, energy performance, porch

1. INTRODUCTION

The energy stakes at the beginning of the twenty-first century largely exceed the energy supply framework. Nearly 40 % of energy consumption final Europe is environment built, of which 75 % are housing. The European Union aims to be virtually carbon-free by 2050, and has already reduced its CO_2 emissions by 55% by 2030, [16]. According to the Ministry of energy and mines of Algeria, energy

---

[1] Corresponding author: Belkacem BERGHOUT, Institute of Applied Science and Technology (ISTA), Hygiene, Safety and Environment Department, University 20 August 1955 Skikda, Algéria, b.berghout@univ-skikda.dz, +213 659 878 668

consumption in the residential building represents 38% total consumption country. Consequently, this sector represents this case 16% of greenhouse gas emissions. Within the framework of the programs initiated according to [19], the actions required at building level are complex and linked to the development of advanced energy systems with a high share of guaranteed renewable energies, involvement of new building materials, improved energy efficiency, implementation of smart technologies, etc. Similarly, the transition to a renewable energy system in this building sector is a complex process comprising various technological elements and influenced by multiple stakeholders and diverse functions [22].

In fact, major studies have long been carried out on this issue, but insufficient progress has been made in practice. At this stage, buildings are now the key sector for reducing fossil energy consumption and greenhouse gas emissions [24]. In line with this, it has been announced by Zhao *et al.* [27] that the intelligent approach is found to demonstrate great robustness in responding to the uncertain and unpredictable characteristics of occupant behavior in buildings, compared with traditional methods.

Methods based on artificial intelligence (AI) and data-driven approaches can improve the prediction of building energy consumption and the recognition of occupant thermal comfort. In addition, recent advances in current computing and the significant increase in data availability from new building systems have renewed interest in occupant-centered control (OCC) as a feasible and scalable control strategy, something confirmed by Ouf [20] as part of the programs initiated.

Furthermore, design and representation methods have evolved towards digital tools, the industry has evolved in materials production and construction techniques, and the profession has diversified into several specialties, including energy [6]. These latest models are being put forward in response to a number of challenges, including the reduction of energy consumption, the use of clean, renewable and local energies, and the capture and storage of carbon dioxide. However, within the same continent, there are boundary conditions in the EU, especially as the Union is a multinational structure with different climatic characteristics and management systems. According to the literature review, five main themes can be identified. These are definitions, climatic conditions, differences in the definition of thermal comfort, the problem of renewable energy production and construction quality [3]. This situation prevents the determination of a common objective in the European Union, hence the need to develop models independently under the climatic conditions of each region [24].

In this perspective, numerous field studies on thermal comfort, based on the adaptive theory proposed by Nicol and Humphreys, in Japan, China, Singapore, Malaysia, Indonesia, Nepal, India, Pakistan and Iran have indicated that the range of acceptable thermal comfort conditions is wider than that provided by standards, resulting in higher energy consumption in buildings for heating and cooling than reported in field studies [1]. The results of previous studies would not be precise enough to draw conclusions on the reduction of energy consumption. In order to offer judicious choices and appropriate solutions relating to energy efficiency and building thermal comfort, the adoption of solutions accessible to architects, with means familiar to them, is considered necessary [7].

The bioclimatic approach makes it possible to align the architectural project with energy performance objectives, a fact confirmed by Abdollahzadeh *et al.* [1], thanks to bioclimatic studies carried out mainly in villas, small buildings or outdoors, the thermal comfort range has been determined in the different climates of Iran. These solutions for integrating devices and strategies into building design form an interface between architecture, engineering sciences and the humanities [8]. These collaborations should lead to results that are useful to architects in the design of buildings offering reduced energy consumption and improved comfort for users. In this context, actors such as the European Council have set ambitious targets: a 20% reduction in energy consumption, a 20% reduction in greenhouse gas emissions and a proportion of 20% renewable energies in energy consumption by 2050.

In this logic, by exploiting the building sector and its potential for improving energy performance. At the same time, the COVID-19 crisis has increased attention to indoor air quality and ventilation in our buildings. The main aim of this article is to concrete to construction professionals in arid zones an advanced concept, exploiting intelligent technologies, enabling the integration of renewable energies into buildings, the implication of new materials and improved energy efficiency. This article focuses on the integration of a porch into the design of a building in a more appropriate way, this architectural device will be exploited to provide shade and help regulate temperatures inside the building in several ways as much protection against direct solar radiation, reduction of radiant heat, natural ventilation, thermal isolation while minimizing the reduction of air conditioning load. In sum, this latest porch integration into a building's design can help improve energy efficiency and interior thermal comfort by regulating temperatures and minimizing the effects of solar heat.

This article is structured into six main sections. The first section introduces the subject and states the objectives. The literature review is described in the second section. The third section describes the methodology. It covers how to integrate and optimize the porch as a traditional feature, derived from the results of the bioclimatic analysis, into the building design taking into account energy aspects and occupant comfort through the development of building design processes. The case study and results of a bioclimatic analysis of the city under study are presented in the fourth section, along with the choice of building. The fifth section deals with the results and discussions. The thermal performance of the porch as a passive technique, integrated as far upstream as possible in the design of a building in the city of Biskra, Algeria, is assessed by dynamic simulation using EnergyPlus software. Finally, the sixth section contains a conclusion that illustrates and synthesizes the results obtained, proposing perspectives for future research.

2. LITERATURE REVIEW

Technological development has given rise to a great deal of research into the energy performance of buildings and architectural design assistance models under the climatic conditions of a given region, capable of simulating the thermal behavior of a building with the integration of devices coupled to it.

These are in fact prototype tools rather than tools suitable for professional practice. To this measure, the results obtained as part of a study carried out by architect constitute a prospect for model evolution by exploiting his COCON software (comparison of constructive solutions, comfort levels and CO_2 emissions), which enables buildings to be designed and compared simultaneously from the point of view of: the thermal requirements of different labels; comfort, particularly with regard to thermal inertia; the environmental impact of the entire life cycle (manufacture of materials, construction, maintenance, end-of-life, use) [13]. Nevertheless, it seems more efficient to consider the environmental aspect and energy performance in particular in the upstream design phases in order to design efficient buildings. In the upstream phases, the designer will lack the information to deal with a problem or make an effective and definitive modification. The further the project progresses, the more information is available, but the designer will lack the freedom to act, and problems will be more costly to resolve.

However, even with the optimal conditions of architectural concepts, analytical approaches are developed in real situations, the comfort conditions encountered vary with the context of the studies, the results obtained by Muselli [18] in a study that deals with the analysis and estimation of new low-cost passive radiative materials in roofs/ France, exploiting the mathematical calculation method /Simulation of the prototype, have well recorded a reduction in surface temperatures of materials with white coatings namely: TCT and PSS: 18%, FC: 25%, CS: 34% and a saving in air-conditioning electrical energy of between 26% and 46% for white reflective roofs, enabling good thermal and energy efficiency of cold roofs and reflective coatings. Without there having been any development of models exploiting the traditional potential to help professionals improve energy efficiency within the built environment of an area in question [12].

Similarly, another study was carried out which focuses, on the influence of reflective coatings on thermal comfort and energy demand/housing in Mediterranean latitudes, carried out by Zinzi *et al.* [28], surprising results were obtained whose objective was to characterize and reduce air conditioning loads and energy demand through the application of reflective coatings, based on energy simulations/measurement of optical properties. In this perspective, Dabaieh *et al.* [11] confirm in arid and semi-arid zones, the case of Cairo in Egypt and the Ksar of Béni Isguen, Algeria, through these results obtained by highlighting for a building integrating in its design passive devices and other buildings integrating in their designs various active systems, that the integration of passive devices in housing design ensures better thermal comfort and that passive strategies generate better comfort. A significant reduction in cooling demand was observed with the use of passive "cold roofs"/buildings, followed by an improvement in energy consumption of 826,00 kWh.

Indeed, according to studies made by Shady *et al.* [23], studies based on heating load can cause overheating during the cooling period, even in northern countries. Therefore, an active heating and cooling system is recommended when such passive buildings are applied. To this end, Ajaj *et al.* [2] declare that the energy performance of the building depends on both the construction and the quality of the design. However, it seems that it is difficult for professionals to exploit these latest models developed, as good energy-efficient building design requires design support tools and that, energy performance has become an objective and not a reflection [4].

With this in mind, a study was carried out on various prototypes to test/develop a mathematical model of a software tool, with the aim of evaluating theWater flow glazing (WFG) and its cooling performance, with dynamic energy simulation validation, the use of WFG helps reduce cooling loads in summer. Energy consumption for a 3,5 m^2 WFG space is 11,39 kWh. CO_2 emissions have been reduced by around 70%. These techniques seem inadequate for the case of a hot, arid climate, since the use of glazing and all transparent materials is inadvisable in deserts (problem of overheating and fire) and WFG will need more energy, which increases the electricity bill [17]. Similarly, Rawat *et al.* [21] proposes a prototype/mathematical model for analytically evaluating a cold roof/composite climate in Madhya, Pradesh, India, resulted in reductions in indoor and outdoor temperatures of 4,1°C and 9,2°C successively. However, bioclimatic approaches have the advantage of being able to consume very little energy. They avoid the use of active systems, and their installation is linked to climatic and environmental adaptation, in order to meet thermal comfort requirements in arid regions [5]. The existing stock of traditional approaches provides a database for this type of approach. What's more, the challenge is a major one, not only from an economic and social point of view, but also from an environmental one.

In parallel, Ibrahim *et al.* [14] carried out a study entitled Benchmarking indoor headroom heights of residential buildings based on ASHRAE Standard 55. The research aims to find out the impact of lintel heights of different residential buildings on indoor operational temperature (Top), influenced by mean radiant temperature (MRT). Using measured variables, the results show that the Top temperature of occupants in models with ceiling heights between 2,2 m and 2,75 m is outside the comfort zone, and that the Top temperature of occupants in models with ceiling heights between 3,25 m and 3,75 m is within acceptable limits. Similarly, in another study entitled integrated application strategy of large-scale intelligent building based on renewable energy technology by Yujuan *et al.* [26], it was demonstrated that the integrated system of intelligent buildings constructed by incorporating renewable energy can meet the requirements of carbon-free green buildings. Simulation results show that the ground-source heat pump equipment is in a shutdown state in summer, while the maximum operating powers of the electrolyzer, hydrogen fuel cell and battery are 30; 10,1 and 10 kW respectively. In winter, the refrigerators do not operate, while the geothermal heat pump operates at a maximum power of 10,8 kW, and the hydrogen fuel cell and battery operate at a maximum power of 13,28 and 10 kW respectively.

Consequently, Ying [25] confirmed in his study of: Construction of intelligent multi-construction management platform for bridges based on BIM technology, that in buildings, energy efficiency can be achieved by using insulation materials, improved architectural techniques and modified construction methodology. At the same time, Taşçı [24] confirmed that for new buildings, there are generally known passive design parameters that need to be taken into account, such as site selection, location, building orientation, environment, building form, optical and thermo-physical characteristics of the building envelope, solar control and natural ventilation systems. Furthermore, suggestions have been prepared for reducing heating/cooling energy requirements by passive methods in each climatic region with climatic characteristics and data obtained from traditional houses. Situation announced by Berghout *et al.* [9], to what extent the coupling between energy issues and architectural devices complicates the determination of optimal solutions. It is difficult to determine, by prior analysis, how the sizing of one device will affect the others. Innovative design strategies that improve building performance, avoid excessive use of resources and promote healthy indoor environments should be implemented to benefit building occupants, reduce air pollution and further the sustainable development of the built environment. However, these strategies do not yet appear to have been studied in depth, and their influence on the energy performance of buildings is poorly understood.

3. METHODOLOGY

This research is based on previous articles dealing with passive ambient comfort and the feasibility of integrating vernacular devices into housing design in arid zones, the passive ambient comfort and the interaction of vernacular strategies and devices in arid zone habitat design: case of Biskra, Algeria and passive ambient comfort and correlation of strategies and vernacular devices for habitat design in arid zones: the case of Biskra, Algeria, prepared for construction professionals, concretize the conceptual process in an advanced way by exploiting intelligent technologies whose objective is to improve the energy efficiency of the building. In the first stage, this proposed methodology enables us to identify the appropriate passive measures to be integrated. The conclusions of this first phase, considered as a bioclimatic analysis, form a database for the second phase.

The second phase presents a proposed flowchart summarizing the steps to be followed in carrying out such research. It enables designers to analyze the passive measures listed in Step 1. To this end, EnergyPlus and ArchiWIZARD software were used to assess the influence of these different passive strategy integrations on the energy behaviour of the building and the comfort of the user.

Access to weather data is an increasingly important consideration for energy modellers. EnergyPlus and ArchiWIZARD have been specifically developed to provide key information for building energy, comfort and daylighting simulations. They enable modelers to access a vast database of high-quality hourly weather data via an easy-to-use web platform. They also include a wide range of analysis tools to help designers select the most appropriate data for dryland cases.

3.1 Concretization of the interaction process

At this stage, the aim is to define the parameters of the interactions underlying the maintenance of thermal comfort for building occupants, based on the satisfaction of cooling and heating needs. This will enable us to form a conceptual framework capable of integrating passive strategies and interaction scenarios between strategies and devices. This approach is rooted in original research into the relationship between energy components and passive ambients, as well as the possibility of integrating passive measures into the building design process and the expected impact of this integration on the environment (thermal behavior and energy consumption). This makes it possible to target a situation in a real-life context where the designer is confronted with various opportunities or suggested actions.

The ultimate aim is to ensure the thermal comfort of occupants, by adapting the building design to the expectations of the designer, who must consider that there is no single solution to meet the energy challenges inherent in building design. This complexity stems from the large number of different variables (passive measures) involved. The designer must bear in mind that his designs are oriented towards the user, not the user himself, and these variables interact in an interdependent way (looping system). Figure 1 illustrates the case of interaction: mutual influence enables a set of passive measures to form a group in its own right, and compensates for the fact that the behavior of each strategy becomes the stimulus for another strategy.

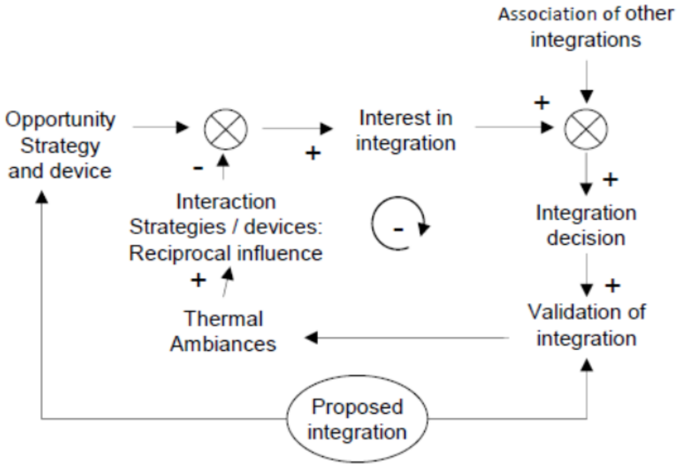

Fig. 1. Conceptual process already developed, to be concretized, case of interaction of strategies and devices

Taking the case of integrating a porch with a building whose temperature is always ambient. Figure 2 illustrates the integration of a porch into the design of a building. In architecture, designing a building means solving a problem which - unlike the exact sciences - does not have a single solution [10], because the designer is not designing for himself, but for the user who will operate the building. The upstream introduction by the designer of the porch into his building design enables him to compare satisfaction at every moment, the result of which generates more or less interest in the proposed action.

Fig. 2. Introduction of a porch into the design of a building
Od Tripoli avenir design architecture

In this way, the action of the association that will actually be carried out corresponds to an anticipated action that should generate a result that will be cumulative in satisfying air-conditioning and heating needs, as in the case of combining passive measures, exploiting renewable energies, involving new materials, natural ventilation as shown in figure 3, planting vegetation around the porch as shown in figure 4, but also controlling solar radiation, all of which is highly dependent on the environment in which the building is located, in order to determine the value of integration in combination with the thermal environment.

Fig. 3. Implication of new materials and natural ventilation in a porch in the design of a building, od Tripoli avenir design architecture

Fig. 4. Vegetation planted around the porch, od Tripoli avenir design architecture

This latter combination can not only reduce heating requirements, but also improve thermal comfort. From the above, it follows that the group formed by the association of other passive measures with the porch will make it possible to respond to the constraints of both summer and winter periods, and that these associated strategies become a stimulus for this initially integrated device. This interest in action will influence the integration action decision, which will determine the action actually taken in response to the proposed action.

4. STUDY CONTEXT

The city of Biskra, Algeria, lies in a latitude of between 20° and 40°, and is characterized by high summer heights, which means that the choice of building form and profile has a major impact on user comfort and energy consumption. As a result, these criteria are important in determining the availability of radiation in the built environment and its distribution over surfaces, and therefore its direct influence on access to the sun. Just as they are important in defining the absorption and reflection capacity of solar radiation.

4.1 The reference building

The RB reference building analyzed here represents a housing typology built between 1975 and 1980 in Biskra, Algeria. As shown in figure 5, it consists of a ground floor and 04 upper floors. The building studied has a total floor area of 1176.74 m^2 and is oriented North-South.

Fig. 5. View of the building units, Biskra, Algeria

5. RESULTS AND DISCUSSION

To evaluate the impact of the porch integrated into the RB on cooling and heating requirements, the monthly and annual cooling and heating loads in kW/h/m^3 of the RB will be compared with the monthly and annual cooling and heating loads in kW/h/m^3 of the RB with porch configuration.

The temperature inside the building is assumed to be constant. Any heat entering or leaving the building must be compensated by the same amount of cooling and heating energy. The cooling and heating loads required to keep the temperature inside the building stable are obtained by comparing the cooling and heating requirements of the RB with those of the building with porch.

5.1 Reference building simulation

In this study, EnergyPlus and ArchiWIZARD are dynamic thermal simulation software used in conjunction to perform more detailed, visual simulations of the energy performance of the reference building named RB. The simulation of the RB is based on the typical annual file of meteorological data for Biskra (typical meteorological year by Meteonorm - TMY). In the simulations carried out, the synchronization of weather data, solar calculations (solar height and Azimuth) and internal load scenarios were checked under the software in question, which even allows convective exchange coefficients to be evaluated at each time step by means of correlations integrating temperature differences between the surfaces under consideration and the air. Summer cooling is simulated using direct expansion fractionation systems with a coefficient of performance of 3.1. Annual heating requirements were simulated using residential radiators obtained from a natural gas-fired boiler, with a heating capacity of 15 kW and an efficiency of 100%.

The simulation was carried out with EnergyPlus in ArchiWIZARD, and the RB was first created in ArchiWIZARD, as shown in Figure 6, with modeling of the geometry, building materials, HVAC systems, windows, doors, etc., and then imported into the EnergyPlus model. Simulation parameters such as weather, simulation period, occupants, internal loads, schedules, etc. were configured. This will enable EnergyPlus to simulate the building's energy performance under real-life conditions. Also, a configuration of the HVAC systems, including heating, ventilation and air-conditioning equipment, and associated controls was carried out. The simulation was then run using EnergyPlus via ArchiWIZARD. EnergyPlus will calculate the building's energy performance over the two specified simulation periods, summer and winter. The results were analyzed in ArchiWIZARD.

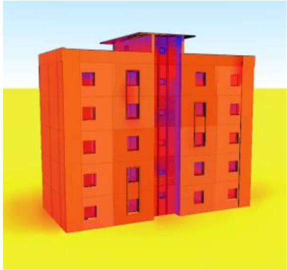

Fig. 6. Building volume corresponds to the RB

Figure 7 illustrates the monthly cooling/heating loads for the building studied, referred to as the reference building. The simulation results illustrate that the cooling energy requirements of the RB during the warm season, from May to October, vary between 12490,522 kWh and 9744,798 kWh, and the heating requirements during the cold season, from November to April, vary between 520,052 kWh and 276,658 kWh. The total annual air-conditioning load is: 118365,191 kWh and the total annual heating load is: 4337,33 kWh.

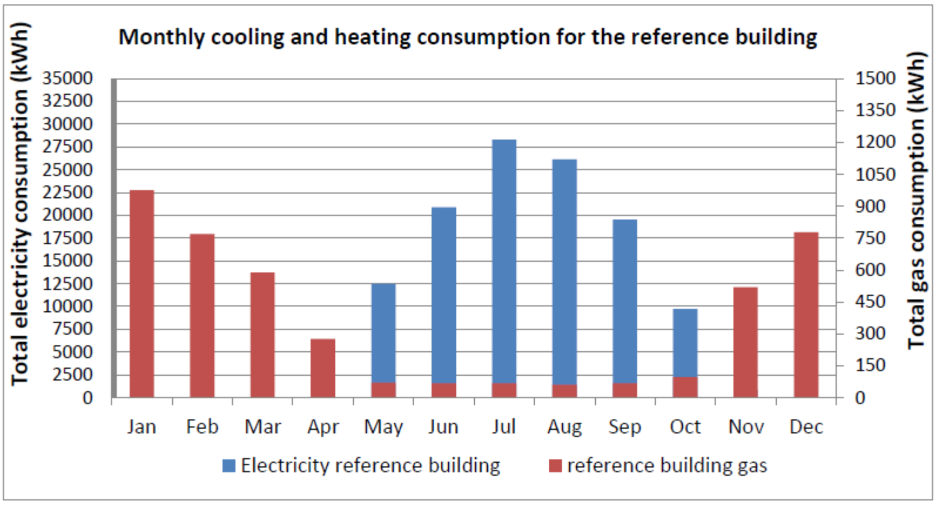

Fig. 7. Illustrates the monthly cooling/heating loads for the RB building

The simulated energy balance of the reference building is: 74,03% kWh/year/m^3, while the average energy balance of a building in Algeria according to the agency for the promotion of the rationalization of energy use (APRUE) in 2014 is estimated at: 58,000 kWh/year/m^3. This translates into an increase in the energy balance of the reference building of: 21,65% compared with the average energy balance for a building in Algeria.

5.2 Building configuration with porch

As described in the conceptual process realization loop in Figure 1, porch integration into the RB, as illustrated in Figure 8, will depend on many factors, including its design, orientation, materials and use. Carefully considered design and integration can contribute significantly to a building's overall energy efficiency.

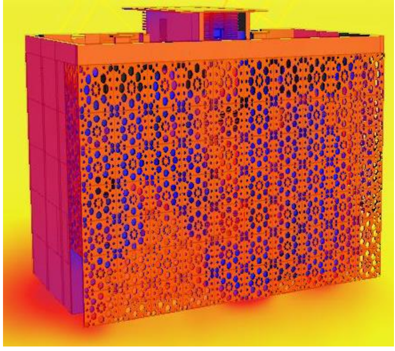

Fig. 8. Building volume corresponding to the configuration for integrating the porch into the RB

Figure 9 illustrates the comparison of monthly cooling/heating loads for the building corresponding to the porch integration configuration with the RB. The monthly simulation results illustrate that the cooling energy requirements of the porch integration configuration building during the warm season, from May to October, vary between 203,632 kWh and 3538,354 kWh, and the heating requirements during the cold season, from November to April, vary between 468,852 kWh and 243,431 kWh. The total annual air-conditioning load is: 53554,535 kWh and the total annual heating load is: 3428,463 kWh. In contrary to the RB, the results of the simulation of cooling energy requirements during the hot season, from May to October, vary between 12490,522 kWh and 9744,798 kWh, and heating requirements during the cold season, from November to April, vary between 520,052 kWh and 276,658 kWh. The total annual air-conditioning load is: 118365,191 kWh and the total annual heating load is: 4337,330 kWh.

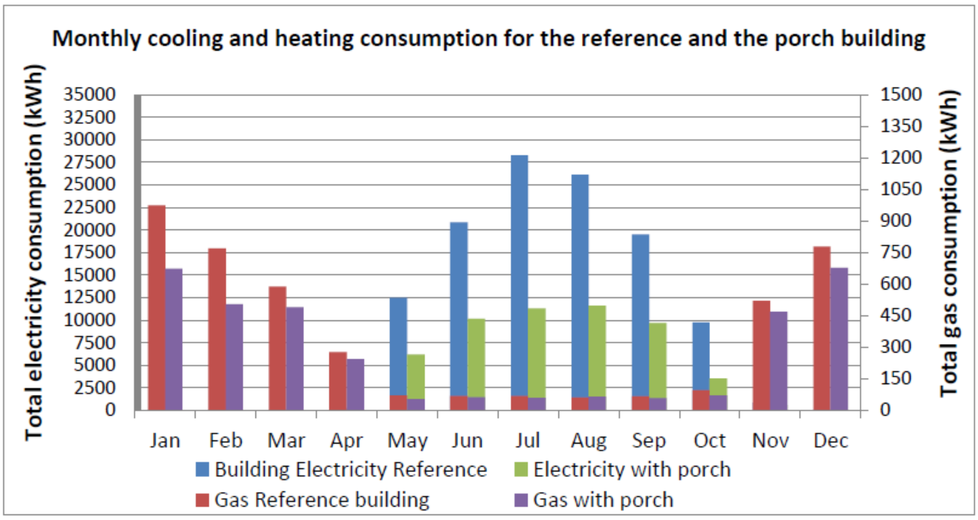

Fig. 9. Monthly air-conditioning/heating loads relative to the thermal environment for the building corresponding to the porch integration configuration compared to the RB

Clearly, a significant reduction in thermal loads is achieved by the latter porch integration configuration, compared to the RB. This is due to the air movement generated by integrating the porch as a structure adjacent to the building, which can be closed, semi-closed or open, depending on architectural style and design objectives. The porch offers the building a shaded area, helping to reduce the heat generated by direct exposure to the sun. In summer, this keeps indoor temperatures cooler, avoiding overheating due to the greenhouse effect. Its integration into the building also blocks out much of the sun's rays, reducing thermal loads inside the building. In winter, this porch helps maintain heat inside the building by reducing heat loss caused by extreme weather conditions.

Spontaneously, the direction of heat transfer is from the higher-temperature space to the lower-temperature one, and by integrating the porch as a buffer zone, the air inside the porch can serve as thermal isolation, preventing sudden temperature changes from penetrating directly into the building, thus helping to maintain a more comfortable, energy-efficient indoor environment. The cycle of this heat transfer stops in this building when the energy requirements for heating in winter and cooling in summer are met in which an ambitious and acceptable indoor temperature is maintained. This explains why the building's energy ratio resulting from the porch configuration is: 34,38 kWh/year/m^3, while the energy ratio of the RB is: 74,03 kWh/year/m^3. This represents a 53,55% reduction in the energy ratio of the porch building compared with the RB.

This porch integration configuration, as described in the realization loop of the conceptual process shown in Figure 1 object of concretisation, could be enriched by a range of very rich passive measures designed with the climate in consideration, it's about the integration by interaction of strategies and devices, a relationship of two terms, one of which logically calls for the other. By exploiting intelligent technologies, making it possible to integrate renewable energies into buildings, using new materials and improving energy efficiency. This final loop in the conceptual process identifies the degree of linkage between the configurations (porch and range of passive measures exploiting intelligent technologies), whose multiplicity and adequacy end up producing relative comfort during both summer and winter periods, composing the envelope and playing a primordial role in the envelope's thermal behavior.

5.3 Synthesis

In architecture, the integration of porches by designers in the arid zone in the design of a building is a pertinent solution, offering the added benefit of improved energy performance.

This architectural porch will create shade and help to regulate temperatures inside the building in a number of ways: protection from direct solar radiation, reduction of radiant heat, natural ventilation, thermal isolation, while minimizing the air-conditioning load. The integration of the porch into the building can also act as a buffer zone between the interior and exterior, reducing heat loss in winter and heat gain in summer. This could help reduce the building's heating and cooling requirements, as illustrated by the simulation results for this integration.

6. CONCLUSIONS

The process of integrating devices into the design of the RB, as clearly demonstrated in Figure 1, has enabled us to analyze the complexity of the dynamic thermal comfort behavior of this RB through the mutual interrelations of the design with the RB.

As part of this research, this latest concrete achievement has enabled the construction of a low-energy residential building, taking into account cooling and heating consumption in relation to user comfort. The results of this study show that integrating porches into the building is a relevant solution.

This integration enabled a 53.55% reduction in the energy ratio compared with the RB.

7. PERSPECTIVES

The interactive integration of the porch with the building's passive measures proves to be a relevant solution. Exploiting the porch in building design brings together a number of passive strategies, such as design, location, orientation, materials used, solar shading, cross-ventilation, daylighting, solar energy harvesting, greenhouse effect reduction, can help regulate indoor temperature, improve air quality and thus contribute to the reduction of greenhouse gas emissions.

REFERENCES

1. Abdollahzadeh, SM, Heidari, SH and Einifar, A 2023. "Evaluating thermal comfort and neutral temperature in residential apartments in hot and dry climate: A case study in Shiraz, Iran." J*ournal of Building Engineering Journal of Building Engineering".*
2. Ajaj, A and Pugnaloni, F 2017. "Re-Thinking Traditional Arab Architecture: A Traditional Approach to Contemporary Living." *International Journal of Engineering and Technology* "**6**. no. August 2014, 286-289.
3. Attia, S *et al.* 2017. "Overview and Future Challenges of Nearly Zero Energy Buildings (NZEB) design in Southern Europe." *Energy and Buildings"*, **155**, 439-458.
4. Berghout, B, 2012. Effet de l'implantation d'un batiment sur le confort. Ets, 184, Quebec, Canada.
5. Berghout, B *et al.* 2014. "Simulation du confort thermique intérieur pour l'orientation d'un bâtiment collectif à Biskra, Algérie, Algérie." *eSim* (2014). Ottawa, Canada.
6. Berghout, B and Daniel, F 2019. "The passive ambient comfort and correlation of strategies and vernacular devices for habitat design in arid zones in "*Buildings"*. **9 (87)**.
7. Berghout, B and Daniel, F 2019. "The passive ambient comfort and interaction of strategies and vernacular devices for habitat design in arid zones « *in Advances in Building Energy Research"*.
8. Berghout, B and Daniel, F 2019. "The passive ambient comfort and design integration feasibility of vernacular devices in arid housing." *in International Journal of Global Environmental Issues"*.
9. Berghout, B and Daniel, F 2019. "Intégration des Aspects Énergétiques et du Confort Ambiant Passif dans la Conception de l'Habitat en Milieu Arides " *Ets (2019). Quebec,* Canada.
10. Conan, M 1990. "Concevoir un projet d'architecture." *L'harmattan",* Paris.
11. Dabaieh, M *et al.* 2015. "Reducing cooling demands in a hot dry climate: A simulation study for non-insulated passive cool roof thermal performance in residential buildings." *Energy and Buildings"* **89**: 142-152.
12. Denis, D 2012. Bâti vernaculaire & Développement urbain durable. "*Etudes et conseil en environnement et développement durable".* Paris, France, Ile de France: **108**.
13. Dutreix, A 2010. "Bioclimatisme et pérformances énergétiques des Batiments*"*. Paris.
14. Ibrahim, T and Seyed, M 2023. "Benchmarking indoor headroom heights of residential buildings based on ASHRAE Standard "**55**. *Intelligent Buildings International.*
15. Jules, D 2015. *Global Research.* https://suds-en-ligne.ird.fr/desertif/carte.html.
16. Konstantinou, T, 2023. "Enjeux, solutions et méthodes pour la transition énergétique dans le parc de logements existan." *Énergie et bâtiments".*
17. Moreno, Santamaria, B *et al*. 2020. "Application and validation of a dynamic energy simulation tool: A case study with water flow glazing envelope." *Energies*, **13 (2)**.
18. Muselli, M 2010. " Passive cooling for air-conditioning energy savings with new radiative low-cost coatings." *Energy and Buildings"* **42(6)**: 945-954.

19. Nilmini, RP, Weerasinghe, P *et al*. 2020. "Renewable energy adoption in the built environment: a sociotechnical network approach." *Intelligent Buildings International"*: **33 (50)**.
20. Nižetić, S 2023. "Les technologies d'avenir pour le secteur du bâtiment pour accélérer la transition énergétique." *Énergie et bâtiments VSI»:* Future Buildings (Demande de papiers).
21. Ouf, M 2022. "Stratégies de contrôle centrées sur les occupants pour les systèmes du bâtiment." "*Énergie et bâtiment"s.*
22. Rawat, M and Singh, R 2021. "Performance evaluation of a cool roof model in composite climate." *Materials Today"*: Proceedings **44**.
23. Shady, A *et al.* 2017. "Overview and future challenges of nearly zero energy buildings (nZEB) design in Southern Europe." *Energy and Buildings"* **155 (15)**: 439-458.
24. Taşçı, G 2023. Defining Nearly Zero-Energy Buildings (NZEB) for Turkey in terms of Boundary Conditions. *6th International Conference of Contemporary Affairs in "Architecture and Urbanism (ICCAUA-2023) ".*
25. Ying, W 2023. "Construction of intelligent multi-construction management platform for bridges based on BIM technology." *Intelligent Buildings International".*
26. Yujuan, Jin and Jiaqi, Wang 2023. "Integrated application strategy of large-scale intelligent building based on renewable energy technology." *Intelligent Buildings International".*
27. Zhao, X, Yin, Y, He, Z and Deng, Z 2023. "State-of-the-art, challenges and new perspectives of thermal comfort demand law for on-demand intelligent control of heating, ventilation, and air conditioning systems " *Energy and Buildings", **27**.*
28. Zinzi, M and Agnoli, S 2012. "Cool and green roofs. An energy and comfort comparison between passive cooling and mitigation urban heat island techniques for residential buildings in the Mediterranean region." *Energy and Buildings",* **55**: 66-76.