Case Studies in Thermal Engineering 12 (2018) 1–7

Contents lists available at ScienceDirect

Case Studies in Thermal Engineering

journal homepage: www.elsevier.com/locate/csite

Some solar passive concepts in habitat through natural ventilation case study: Dry climate in Algeria Ghardaia

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ARTICLE INFO

Keywords:
Solar passive concepts
Natural ventilation
Temperature
Building
Climate
Windows opening

ABSTRACT

The main objective of this paper is to study the effect of one of the most important negative concepts through natural ventilation as an economical solution and an inexpensive health phenomenon. Ventilation of buildings is a commitment and requires a minimum of flue that must be guaranteed to avoid discomfort. Air leakage in heated space increased incoming flow rates. Therefore, the leakage in the envelope building plays a major role in thermal losses. Loss created by air exchange system. So experts stressed that opening and closing windows provides a way to control the outside air in all cases. Through the daily programming schedule by climate and region, for example Ghardaia. The area of Ghardaia features characteristics of a high temperature zone especially for the months May to October. This period is characterized by climate and is often hot and in our case with habitat to strong thermal inertia of it can generate discomfort. In this case the thermal inertia is not suitable. Therefore, no other solution of ventilation night becomes more important in hot weather.

1. Introduction

Ventilation in a building is a fundamental function, at the same time the importance of good indoor air quality is evident [1]. Natural ventilation occurs in buildings, it realizes the air exchange for the hygienic minimum or even more, protects from moisture damages and can provide good thermal comfort by intensive ventilation [2]. There are also improper practices, especially in the urban areas where congestion through roads and pollution caused by the deterioration of indoor air quality of homes when close to the roads and this is the result of not taking these influences into account. Studies have shown both (Chen and Chao, 2011; Leung, 2015; US EPA, 2014). That the negative practices of natural ventilation may cause deterioration in indoor air quality. Where the study conducted by Zheming Tong showed, we employed a CFD-based air quality model to quantify the impact of traffic-related air pollution on the indoor air quality of a naturally ventilated building. To minimize the problem, we have to understand the relationship between air quality in indoor and outdoor environments, especially for design, effective natural ventilation strategies [3]. The natural ventilation of buildings depends on climate, building design and human behaviour. With natural ventilation the internal building structure is cooled through open windows and/or air vents.

In the literature, numerous research studies have been undertaken on whether to use natural ventilation in buildings, several research works have revealed that natural ventilation solutions of the building have a significant effect on both the thermal performance and of energy consumption cost [4].

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https://doi.org/10.1016/j.csite.2018.02.002
Received 5 November 2017; Received in revised form 14 February 2018; Accepted 17 February 2018

The circulation of air around buildings is complex and is the subject of many textbooks (Aynsley, Melbourne & Vickery (1977), Liu (1991), for example). Wang et al. [2] justified that heating and ventilation are certainly the key parameters to ensure a pleasant thermal comfort [2].

Yujiao Chen study the impact of climate on natural ventilation for 1854 locations around the world by calculating the NV hour. she demonstrated that NV hour derived from outdoor meteorological data can measure maximum energy saving potential of NV without conducting detailed Building Energy Simulation.

While the design of buildings according to natural ventilation systems depends heavily on the characteristics of the local climate, which vary from region to region.

This research enabling us to develop plans that are appropriate for each region according to the circumstances Climatic conditions, which is based the maximum and minimum variable values of days of cooling degree and days of heating degree.

Yujiao Chen has used the adaptive comfort model De Deer and Brager instead of using a higher temperature threshold in general, which is based on the idea that the external climate affects indoor comfort because humans can adapt to different temperatures during different times of the year.

Where the NV clock is used as an indicator to measure the maximum natural ventilation potential of each location and determine the appropriate number of hours to take advantage of natural ventilation. Through meteorological data, we can say that natural ventilation alone cannot satisfy satisfactory thermal comfort due to high build load especially in the highly deserts and low rainfall with large diurnal temperature range such as my country Algeria in Ghardaia the big south.

2. General characteristics of the city of ghardaia

The city of Ghardaia is located north of the Sahara and north-east of the Great Western Erg, and it is characterized by an arid or even hyper arid (Saharan) climate where temperatures can reach 50 °C in summer and −3 °C in winter. Characterized by a dry and hot desert climate (Köppen classification: BWh), the municipality is located in the time zone UTC +1: 00 (Africa / Algiers).

Ghardaïa (latitude 32.48°N, longitude 3.80°E) has a hot, dry and desert climate, the region is marked by large temperature differences with a clarity index of 0.8. It has a very important rate of insolation (75% on average) and the mean annual of global solar radiation measured on horizontal plane exceeds 20 (MJ/m^2). The annual average temperature is about 22.61 °C.

Minimum temperatures of the coldest month are observed during the month of January with 5.5 °C, while maximum temperatures of the warmest month are observed during the month of July with 41.7 °C. The relative humidity is very low; it is of the order of 21.60% in July, reaching a maximum of 55.80% in January and an annual average of 38.33% [5–8].

In recent years this city has undergone a metamorphosis with a very high rate of urbanization. The use of building materials unsuited to the Saharan climate has pushed the inhabitant to resort to artificial heating and cooling solutions (appliances) that are known to be very energy-intensive.

This has led us to seriously consider finding alternative and negative solutions to reduce consumption, for example, night ventilation to renew and refresh the air.

3. Presentation and building modelling

The studio is located in the research unit Applied Renewable Energy Unit in Ghardaia (URAER), located on a plateau overlooking the Mezab Valley. This zone is characterized by a less dense urban fabric and the absence of peripheral vegetation, which makes it vulnerable to all directions of the wind. The study was carried out on a studio apartment in Ghardaïa. The exterior envelope apart from contributing to the energy savings during the building life by controlling the energy exchange between indoor space and environment developed a comfortable indoor environment [9,12,13]. Fig. 1 is a schematic outline of This studio apartment, the studio has a net area of 43.56 m^2 (6.6 × 6.6), and wall heights are equal to 2.8 m while the other dimensions are shown in detail in Fig. 1. The flooring is placed on plan ground to lodge the ground floor. The concrete of the flooring is directly poured on the ground thus minimizing losses. Floor tiles are end coating resisting to corrosion and chemical agents [13]. The roof is composed of cement slabs and concrete slab made so that it handles the load and be economical. A roof sloping of 5° allowed water evacuation through several openings. The flat roofs are considered the air infiltration in it as architectural solution. Windows and doors contribute significantly to the energetic balance. Their contribution however depends on several parameters as: local climate, orientation, frame, relative surface (window-flooring), and concealment performance during night and sunny days. In this case focus is made particularly on windows and doors dimensions and all are made of woods.

The thermal comfort in the different areas of the habitat cannot be achieved without making a preliminary and judicious choice of building materials. Habitat must therefore ensure a direct response to climatic constraints specific to each region.

For heat exchanges between the exterior and interior environments of the habitat, the envelope plays a decisive role thanks to its thermal properties. Depending on the nature of the envelope materials, the heat from the outside can be damped and even delayed before it enters the room.

In our model, the openings are on both north and south surface for the building with a main door on the East side, during the day the temperature of the outside air is greater than that of the interior. To eliminate the exchange ventilation with outdoor air, the windows and the door will be closed during the day, opened the night (the window and the door will be closed is the time or Tai < Tao and be opened Tai > Tao) [9–12]. By numerical simulation of the model is determined corresponding to each case. For better ventilation of the interior during the night, the door and the window will be on two different opposite wall, it is necessary to seek their guidance for minimized heat gain. During the day the windows and the door will be closed. heat transfer is carried out as