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The Effect of Low Rise Residential Buildings Design Formation on Energy Performance (Iraq Hot Desert Climate as an Example)

Susan Abed Hassan[1]

[1]Department of Architectural engineering, College of Engineering, Al- Nahrain University-Iraq
Email: dr.susanabedhassan@eng.nahrainuniv.edu.iq ,suzana302002@yahoo.com

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Abstract
Residential buildings design formation varies according to the environmental, constructional and functional requirements. The environmental aspect is the most significant requirements that connect with energy performance. Last decades considerable attentions were made about the energy consumption for residential buildings. Previous studies showed that total energy consumption for residential building reached to 40% from the total energy consumption. This research problem is that no obvious recent research about the effect of the low rise residential buildings design formation as a prototype of residential buildings in Iraq on reducing energy consumption. In this study several options for low rise residential buildings design formation were selected for the assessment of energy consumption. Software simulations were used to estimate the energy performance model for different residential buildings design formation. Results demonstrate that contiguity of residential buildings had better results in energy consumption reached to 48% as compared to buildings with no contiguity. Also buildings with north orientation reduce energy to 14% as compared to other orientations.

1. Introduction

The building manufacturing consume large portion of total energy consumption for cities during construction and operation phase[1]. This was accompanied by the appearance of rise of temperatures degree in all world countries, especially in the countries with hot desert climate like Iraq. Last decades many attempts were made to developresidential building's design formations to adapt the climate changes and consume less energy. In order to guide the designer to most efficiently design formation. The most prominent features for the design formation are the orientation and contiguity of buildings. Many recent literatures studied the relationship from different sides of view. El-Deeb, et.al (2012) [2]examined the impact of the shape and configuration of typical buildings form, on the energy consumption in the Middle East hot climate cities. Bekkouche, et.al.(2013) [3] studied the effect of building orientation on demands of energy in hot desert climate, and compared it with the effect of insulation of buildings materials. Salvati, et.al (2017) [4]studied the impacts of urban configuration compactness on the energy demands for buildings.Nasaruddin, et.al(2018) [5] studied the computer programs simulation in estimate needs of energy for building in different stages of construction. Hassan(2018) [6] studied the effect of shapes and materials for residential buildings on the energy demands for hot desert climate. From recent studies it can be concluded that there is no obvious awareness about the effect of the low rise residential buildings formation (contiguity and orientation) on reducing energy performance in Iraq hot desert climates. From recent studies it can conclude that research problem no obvious research about the effect of the low rise residential buildings design

formation as a prototype of residential buildings in Iraq on reducing energy consumption. This paper tries to fill the gap by using software simulations to explore how orientation and contiguity influence building energy performance within.

2.Iraq hot Desert Climate

The most characteristic features of hot desert climate is the sunny and hot dry climate. Maximum temperatures are over 40 °C in summer and can reach to over 45 °C in the hottest regions. In winter temperatures can drop at night to freeze. According to Koppen-Geiger climate classification most of the lands of Iraq are in hot desert climate (BWh) as shown in Figure 1. Average annual temperature is varies from 8.5ºC to 49°C [7]. As for the relative humidity, in winter it can reach up to 100%, where in summer it is around 25%. Iraq is situated on the yellow belt of the earth which means it receives maximum solar radiation during the day. The average daily solar radiation value for horizontal surfaces in Baghdad is 4800 Wh, this is due to the high solar angles of the region (Global Map).

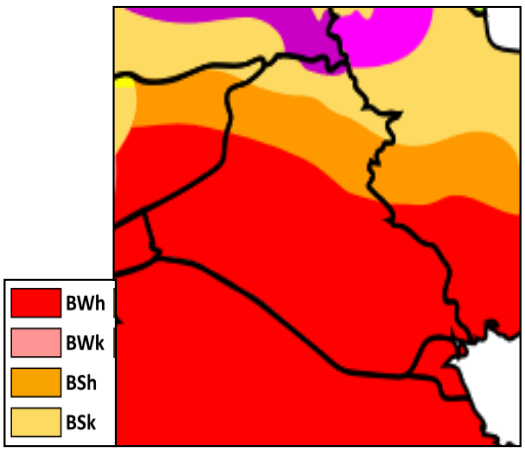

Fig 1.Shows the Koppen-Geiger climate classification for Iraq[8]

3. Low rise residential building in hot desert climate

There are many considerations in formation of building in hot desert climate that effect on energy performance, like building orientation, space between buildings, building shapes, materials of structure, and window to wall ratio [9]. In Iraq the common types of residential buildings are low rise buildings with two to three stories. The climate of mostly Iraqi land is in hot desert climate. The designer has to study the effect of climate on the design formation of low rise residential buildings. According to the most effected design parameters on the energy performance.

4.Research objectives

The main objective of this research is to contribute understanding of the impact of low rise residential buildings formation on the energy performance in hot desert climate. This can be achieved through:

- Investigating the using of various options of low rise residential buildings orientations on energy performance.
- Investigating the using of various options of low rise residential buildings contiguity on energy performance.

5. Methodology

Research studied different low rise residential buildings orientations, and contiguity. Simulation was made using Rivet and Ecotect software 2011. The average building area 100 square meters, dimensions for walls were (10 m*10 m), two stories building, and brick wall materials, which is the common type of low rise residential buildings in Iraq. The tested orientations included (south, north, east, west, east, south east, south west, north east, and north west). These orientations were tested in case of being buildings contiguity with other buildings in the same number of stories height. Then another tested were done to the contiguity ofbuilding that included (three sides, two sides, and one side). The effect of it was addressed by comparing the energy consumption of the selected samples with case of north elevation and contiguity by three sides. Percentage changed was calculated and compared accordingly.

6.Results and Discussions

The results showed that the effect of different low rise residential buildings orientations, and contiguity on energy performance was different in each the tested case.

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6.1.The effect of building orientations on energy performance

The tested orientations include (south, north, east, west, east, south east, south west, north east, and northwest) as shown in Figure 2. The effect of it was addressed by comparing the energy consumption with that case of a north elevation and contiguity by three sides. The results are shown in Figure 3, and Table 1.

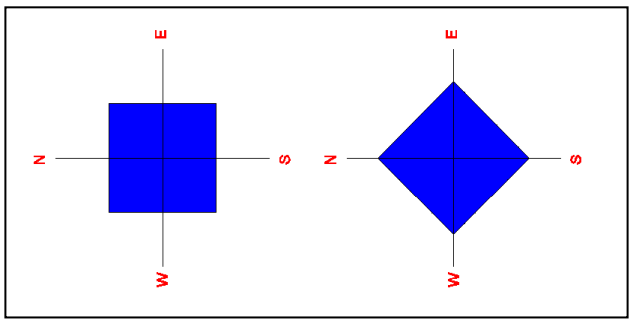

Fig 2. The tested building orientations

Table 1. The effect of building orientation on cooling energy consumption

Energy consumption in Wh. Orientations	Max. Month	Max. Hour	Total	Per. M^2
South	104120.1	6214.1	1275731	12.75731
North	100207	5807.2	1166662	11.66662
East	111308.3	6382.5	1325563	13.25563
West	111489.1	6360.1	1325971	13.25563
South east	108876.5	6287.8	1325734	13.25563
South west	108807.1	6374.7	1326022	13.26022
North east	106775.7	6151.3	1241362	13.26022
North west	106973.7	6055.5	1241500	12.41500

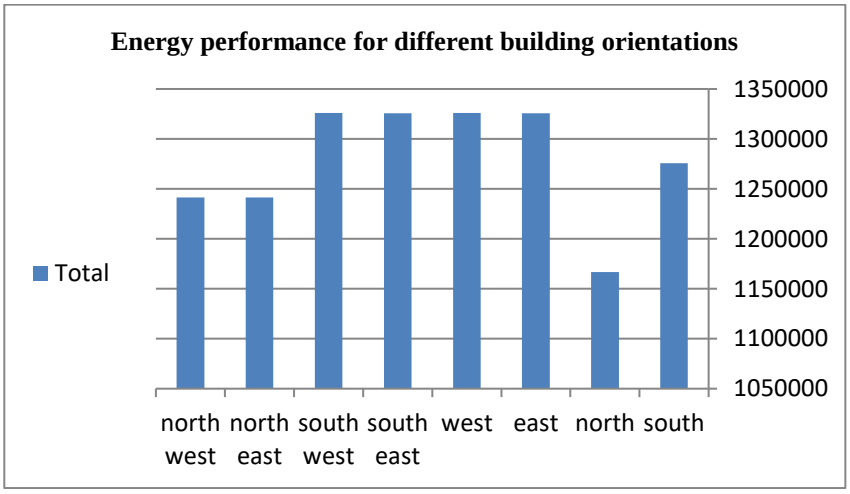

Fig 3. The cooling energy consumption for different building orientations

As shown in Table 1. Building with north elevation provided better results. It consumed lessenergy. The other orientations provided very little energy savings in comparison with the north. West, east, south west, south east elevations increased consumption by 14% as compared to the energy consumption for the north elevation. South, North West and north east elevations increased consumption by 7% as compared to the north elevations energy consumption.

6.2.The effect of building contiguity on energy performance

The contiguity of two stories low rise residential buildings were tested, that includes contiguity of (no contiguity, contiguity from one side, two sides, and three sides) as shown in Figure 4. The effect of it was addressed by comparing the energy consumption of the selected form with building contiguity by three sides. The results are shown in Figure 5, and Table 2.

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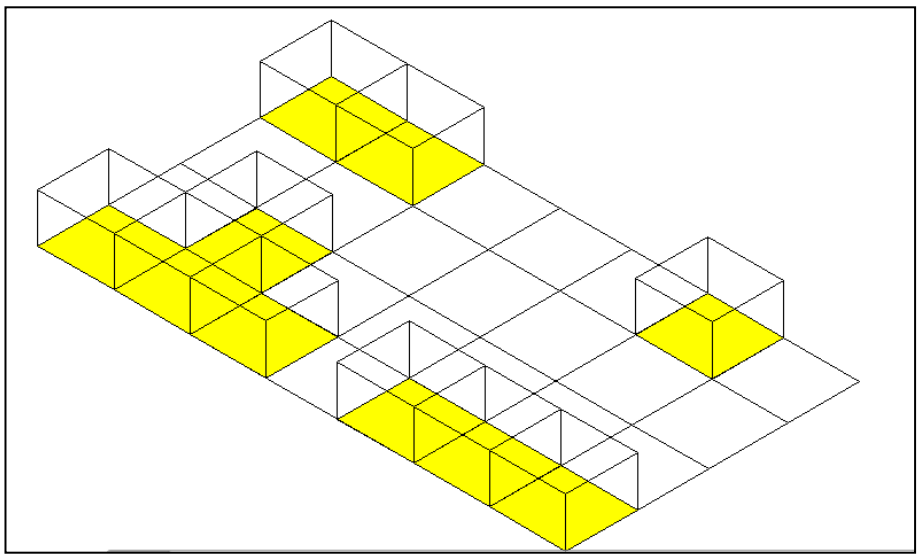

Fig 4. The tested contiguity for low rise residential building

Table 2.The effect of building contiguity on cooling energy consumption

Energy consumption for cooling in Wh	no contiguity	contiguity one side	contiguity two sides	contiguity three sides
Max. Month	203020.3	171661.7	139190.5	106775
Max. Hour	10181.4	9047.1	7538.3	6151
Total	2416786	2081334.2	1661201.8	1241362
Per. M2	24.16786	20.813342	16.12018	12.41362

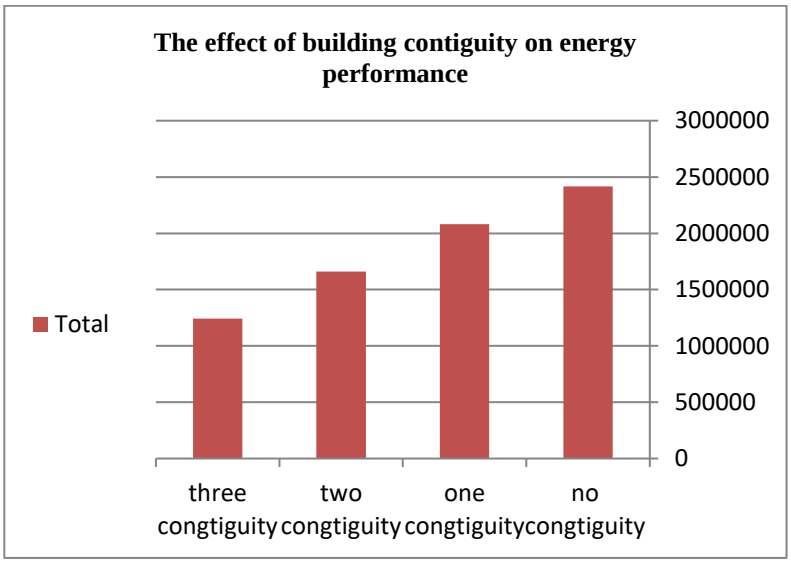

Fig 5. The energy consumption for different building contiguity

As shown in Table 2 building contiguity from three sides provided better results. It consumed lessenergy by 48% as compared to no contiguity building, and 68% as compared to one side contiguity building, and it reduce energy by 33% as compared to two sides contiguity building

7. Conclusion

The low rise residential buildings design formation effects on energy performance in Iraq hot desert climate. The most effected consideration is the contiguity of buildings. The reduction of energy consumption reached to 48% for three sides' contiguity as compared

to the same building with no contiguity, and 33% as compared to one side contiguity building, and it reduce energy by 34% as compared to two sides' contiguity building.
The other design consideration that effect on energy consumption building is the orientation of building, but it did not influenced significantly as compared to contiguity of building. The less energy consumption is north elevation that provides reduction in energy. It consumed less energy by 14% as compared to the orientations of west, east, south west, south east, and reduction in energy by 7% as compared to the orientations of south, north west and north east elevations.

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