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The optimal utilization of solar energy in residential buildings in light of the Jordanian building regulations

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ABSTRACT

The main purpose of this paper is to examine the effect of the current Jordanian building codes on the performance of residential buildings in Jordan. It analyzes the appropriateness of these codes to purvey thermal comfort in spaces and save energy using DEROB-LTH (Building Energy Software Tools Directory). Various variables have been studied such as: the orientation of building, the setback distance between buildings and building envelops by choosing the most suitable external windows in terms of type, size and orientation. The study took Abu Nusseir city in Jordan as a case study for semi-arid regions in Jordan and found significant influences of building regulations such as the setback between buildings on the thermal performance of residential apartments.

The study recommends that decision makers review all regulatory policies including the current building codes that influence energy saving in buildings to set up effective guidelines to meet the safety and healthy requirements for occupants in residential buildings.

1. Introduction

Throughout history, energy consumption has been affected by the expansion of human population (Goldenmberg, 1988). There is a strong relationship between energy and population, the higher the population, the higher of the energy demands (Austain & Brewer, 1970).

The population of Jordan is about 7 million due to the high birth rate and because of the successive migrations to Jordan from neighboring areas because of the wars and political conflict (Jaber, 2002).

In Jordan, the residential sector takes a high percentage of buildings; the number of buildings in 1999 was around 450,000; 92% of which are residential buildings (Jaber, 2002).

On the other hand, Jordan imports all of its fuel needs. This costs approximately 859 million US dollars per year (NERC, 2004). Furthermore; the residential sector in Jordan consumes 24% of the total expenditure. Therefore, raising the level of maturity toward achieving a good level of thermal comfort with the lowest possible cost in residential buildings is a vital issue and should be taken into consideration (Al Zoubi & Al-Shboul, 2010).

Moreover, solar energy is the main source of energy for the earth (Ralph, 2003). Recently, the whole world tends to conduct their research to utilize the solar energy as much as possible, investing all their financial resources (Bezdek & Cambel, 1982; Watson, 1979).

From this global trend, the governments and decision makers in Arab world should pay more attention to utilize the sources of solar energy, due to their distinguished geographical location (Al Zoubi & Al-Shboul, 2010; Omer, 2008).

Building design should be compatible with the environmental conditions, solar energy, and climate (Hu, 1981). At the same time, it should fulfill the human comfort needs with minimal thermal loads (Harris, 1981; Ne'eman & Hopkinson, 1976; Obolensky & Korzin, 1982).

Few research studies in Jordan discuss the effect of solar energy on architectural design policies that keep a good thermal comfort in buildings.

Therefore, this paper investigates the impact of local building codes in Jordan on architectural elements design, such as dimensions of setbacks and designs of building façades to improve the thermal performance.

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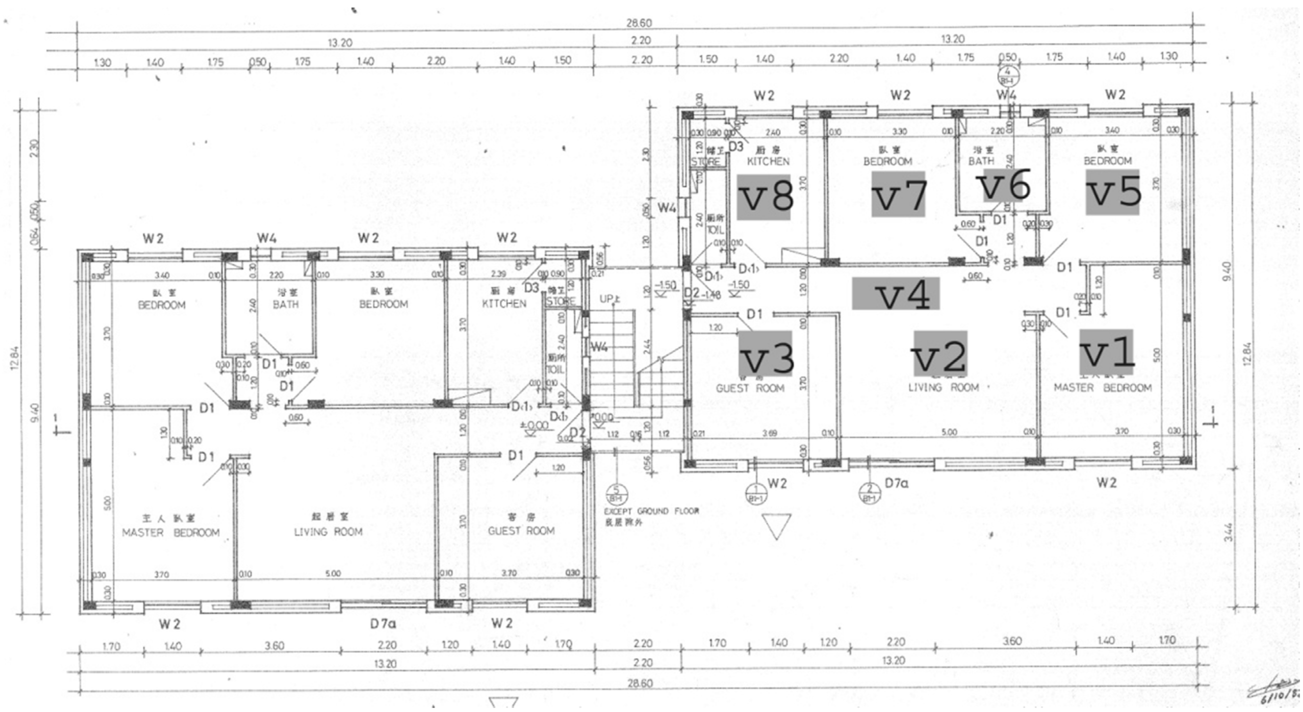

Fig. 1. A typical plan for type (B) apartment.
Source: (HUDC, 1986).

It also seeks proper guidelines that may help decision makers assess the current codes and their roles in utilizing the solar energy.

2. Methodology

This study took Abu Nussier housing city in Amman as a case study because it is planned purposefully for the residential sector in Jordan. It has a special construction style and a topography that causes solar energy problems.

The main variables handled in this research are building orientation, the dimension of setbacks, and the ratio of window size to the wall area. (DEROB-LTH. Building Energy Software Tools Directory) was used to simulate and explore the effect of the above mentioned variables. This program calculates the optical and thermal properties accurately for glazed surfaces (Källblad, 1998; Jacobs & Henderson, 2002).

Two samples of three-story apartments; classes A and B were simulated using DEROB-LTH, each of these stories has two flats. One of the flat includes 8 spaces (volumes). The total number of spaces is sixteen spaces (volumes) with different sizes and orientations; all of them were studied in terms of heating and cooling loads (see Figs. 1–6).

Different variables were analyzed; the orientation of buildings, the setback distance between two adjacent buildings at different distances ranging from three to seven meters. It also handled the ratio of window size to wall area at different percentages; 0%, 20%, 30%, 40%... 100%; to explore their influence on the heating and cooling loads for each floor of the buildings.

The simulation process tackled different parameters; specifically, building geometry, thermal and optical properties of building elements, internal loads, airflow, and schedules.

The geographic data for Abu Nussier housing city in Amman were necessary for the simulation process; it is located at latitude of 32° N and the longitude of 36° E. The weather of Amman is hot and dry in summer and cold in winter which also characterizes the climate of Abu Nussier city. The climatic parameters in the software contain hourly information such as outdoor temperature (°C), solar radiation (MJ/m^2 day), relative humidity (%), wind speed (m/s), sunshine (h/day), and rainfall (mm).

One volume for each space in the building model was considered for the simulation. Sixteen volumes in total were considered to meet the simulation requirements. The volumes (V5, V6, V7, V8, V14, V15 and V16) were oriented to the north and the volumes (V1, V2, V3, V9, V10 and V11) were oriented to the south (see Figs. 1 and 4). The dimensions of the volumes and windows

Fig. 2. A north elevation for type (B) apartment.
Source: (HUDC, 1986).

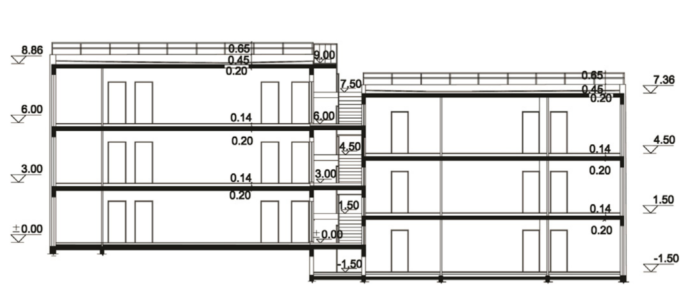

Fig. 3. A section for type (B) apartment.
Source: (HUDC, 1986).

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