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Thermal performances of traditional houses in dry hot arid climate and the effect of natural ventilation on thermal comfort: a case study in Damascus

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Abstract

Traditional houses in hot arid climate of Mediterranean area consist of rooms around one or more courtyards giving a general good comfort conditions especially in hot summer periods. This paper aims to contribution to evaluate the influence of thermal performance of building structures and natural ventilation (cross ventilation, single side ventilation) on the indoor thermal comfort for traditional houses and courtyard located in Damascus old city. The paper shows results of several monitoring data (air temperature, humidity and air velocity) acquired during a summer period, in parallel with occupancy survey for the evaluation of comfort conditions.

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Keywords: traditional houses ; natural ventilation ; thermal comfort ; courtyard ; adaptive model.

1. Introduction.

The oldest heritage buildings in hot arid regions represent good engineering solutions to the external climatic conditions: high temperature and solar radiation in summer (which is the longest period respect to winter period) big thermal excursion between day and night (both in summer and winter).The Damascene settlers, since several centuries ago, responded to all changes of these negative weather conditions through a creative flexible building engineering “harmony” until reaching to balancing the heating and cooling in a marvelous unity. It allows generally

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to mitigate the impact of different climatic variations and to absorb particularly the heating's surplus throughout an integrated texture (thermal mass).

Therefore many researcher by worldwide, especially of the Middle East region, have studied the passive control methods of traditional building which gave comfort conditions over the years. Ahmad E. [1] monitored a traditional courtyard house within a six centuries old indigenous urban cluster and compared it to a modern detached house within a new urban development under summer and winter climates of Ghadames, Libya. Al-Hemiddi and Al-Saud [2] studied experimentally the cooling effects in a building with an internal courtyard in a village house in Saudi Arabia. Changes in the courtyard ventilation were made by opening inner and/or outer windows in alternate ways during the day and night periods; besides he studied the effects of cover and uncover courtyard, closing it at day time and open it at night time by a tent. Abdulhak Mohammed [3-4] studied the effect of climatic factors on people in the Republic of Yemen, also analyzing bioclimatic conditions of some Yemeni cities, presenting contrasting differences in different regions: Sana'a (Cold in Winter), Adan (Hot-Humid) and Say'un (Hot-Dry). Farghal-AMGAD [5]investigated the thermal environment and its effect on the comfort mechanism in the hot arid climate of Cairo, also the natural ventilation effects in spring and autumn periods. Sadafi et al. [6] studied the interaction between indoor and outdoor thermal comfort. The contribution of inner courtyards to the comfort of terrace housing in tropical climate was studied by model and measurements. Other researcher [7-11] studied thermal comfort for traditional building with also courtyard.

This research investigate the thermal conditions for varying Damascus traditional houses depending on the courtyard presence. The combination, in those traditional buildings, of passive cooling techniques with high efficiency in natural ventilation (single sided and cross ventilation), coupled with the effects of massive construction and design assembling, provide a good thermal conditions within most of interior spaces; this strategies allow to conserve energy in a hot-arid region, reducing energy needs for air conditioning.

2. Experimental investigation.

2.1. Field investigation.

The buildings investigated represent two types of typical Damascus traditional houses; the first one is the largest (with two or three courtyards), the second represent the smallest one (with one courtyard) comparable to a part of the first one (in some cases the big houses are divided into small houses, each one with its own courtyard and characterised as a new intervention). Generally they present different room's orientation and various building materials.

These buildings are located in different part of old Damascus city, inside and outside the walls; they consist of two floor levels, with heavy mass (stone and lime) at first level and light mass (timber structure with mud and lime plaster) at the second one. The First type case analyzed (multi-courtyard houses) are located in the same area close together, while the second type (one courtyard houses) are located in a different part of the old city and they are influenced by the old urban fabric specially for narrow streets around houses (effect of wind tunnel).

- First type buildings. BAIT FAKHRY AL BAROUDI (Fig.1); it was recently restored where lime and mud mortar was replaced by concrete, and also hemp and clay replaced by bitumen roll; BAIT AL MOUSLLI: this house still maintains his old configuration and structure.
- Second type buildings. BAIT WARRD: the courtyard is covered with sliding plastic roof; BAB AL SALAM HOUSE: his configuration and structure were subjected to a lot of interventions also in design; every room has been equipped with a bathroom, that means a lot of brick block and plaster used although the concrete slab structure is like the others .