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Frontiers of Architectural Research

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RESEARCH ARTICLE

Traditional courtyard houses as a model for sustainable design: A case study on BWHS mesoclimate of Iran

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Received 15 October 2016; received in revised form 15 April 2017; accepted 27 April 2017

KEYWORDS

Sustainable design;
Traditional courtyard
houses;
Physical-
environmental design
model;
Hot-arid climate;
BWHS mesoclimate;
Iran

Abstract

Manifestations of sustainable design require renewable resources, impact the environment minimally, and connect people with the natural environment. This article is aimed to investigate the concept of Iranian traditional courtyards, as microclimate modifiers, for sustainable building design in hot-arid regions. To this end, a quantitative field survey is conducted to analyze various physical elements including the orientation, dimensions and proportions of enclosed and open spaces, physical bodies (opaque walls), and transparent surfaces (openings) as well as natural elements (water and soil) in nine valuable Iranian traditional courtyard houses from BWHS mesoclimate. In conclusion, all survey-based data are integrated to propose a physical-environmental design model for courtyards in this region. Proposed model can be generalized to all design cases, where located in BWHS mesoclimate with similar environmental conditions.

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1. Introduction

Sustainable design is a design approach put in place to promote the environmental quality and the quality of building indoor environment by reducing negative impacts on building and the natural environment (Iwano and Mwasha, 2013), whereas most of the modern buildings are

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Peer review under responsibility of Southeast University.

<http://dx.doi.org/10.1016/j.foar.2017.04.004>

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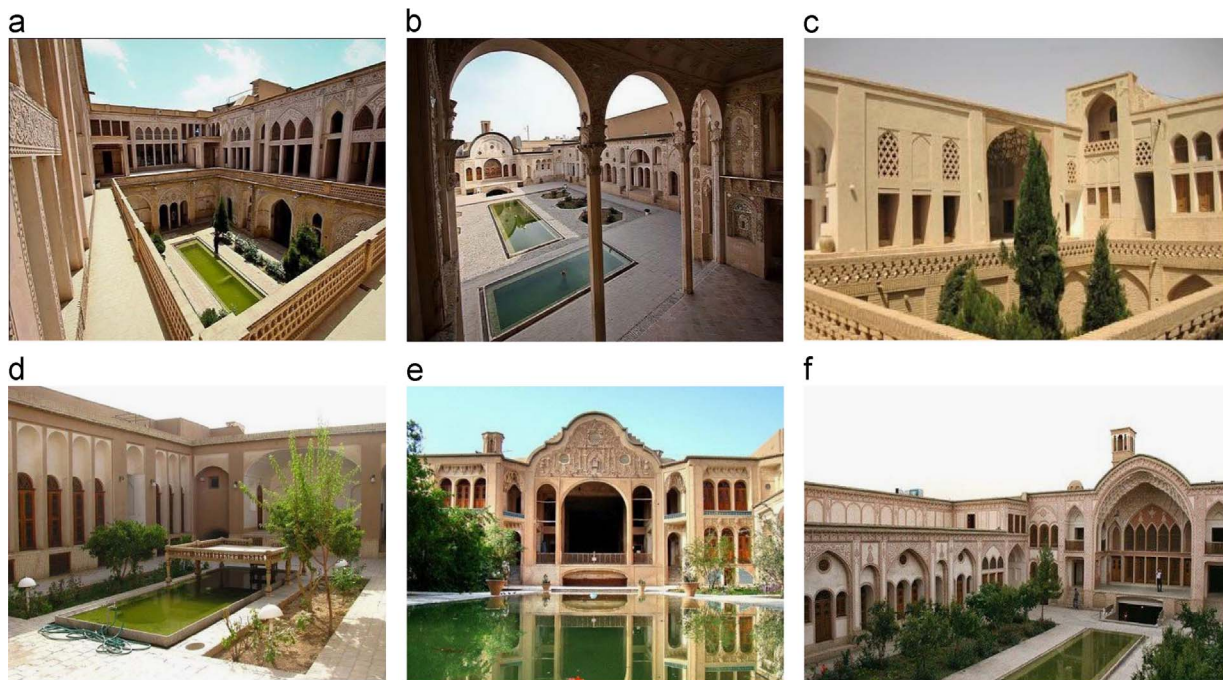


Figure 1 Iranian traditional courtyards as microclimate modifiers, (a) Abbāsi House, Kashan, (b) Tabātabāei House, Kashan, (c) Pirnia House, Yazd (Soflaei and Shokouhian, 2005), (d) Navab Vakil House, Yazd, (e) Borujerdis House, Kashan, and (f) Ameri House, Kashan (Soflaei and Shokouhian, 2007).

designed without adequate attention to the environmental impacts.

One of the most successful samples of climatic responsive architecture is traditional courtyard houses in the hot climate of Iran, which were designed with the careful attention to the climatic requirements and socio-cultural contexts. Moreover, central courtyard itself is one of the most effective elements, it can be defined as a room in the center of the house; it has no roof but generally has a paved section, pool, many trees and flowers to create a self-sufficient microclimate.

A central courtyard, as a passive cooling strategy, operates as follows: the air in the courtyard becomes warmer as the day progresses toward nighttime. Cool air is stored in the courtyard in laminar layers and flows into the rooms surrounding the courtyard and then the temperature in the courtyard slowly increases in the morning, allowing the courtyard to remain cool until solar radiation falls directly onto it. Warm wind passes over the house during the day, and does not enter the courtyard and merely creates eddies inside it, unless baffles are installed to deflect airflow (Soflaei, 2004) (Figure 1).

Previous research have emphasized on the potential of courtyards as microclimatic modifiers to provide indoor thermal comfort (Bagneid, 2006; Muhaisen and Gadi, 2006; Al-Masri and Abu-Hijleh, 2012; Cho and Mohammadzadeh, 2013). Scholars have found that the level of thermal comfort in a courtyard is determined by microclimatic factors, particularly solar radiation and wind. The effects of these parameters have been evaluated by considering the orientation and geometric properties of a courtyard as the most influential design parameters to provide appropriate

thermal comfort (Meir, 2000; Rajapaksha et al., 2003; Fardeheb, 2007; Almhafdy et al., 2013; Toe and Kubota, 2015; Soflaei et al., 2016a, 2016b). According to Reynolds (2002), the application of courtyard that disregards its basic design characteristics and placement would affect its potentials. The design variants that are said to affect its thermal performance include its configuration and aspect ratio, orientation, boundary conditions and degree of exposure, and wall types. It has also identified that the average size of courtyards is generally determined according to latitude, although the size of the land is influential to a certain extent. Courtyards are sufficiently narrow to maintain a shaded area during summer, and yet sufficiently wide to receive solar radiation during winter (Donham, 1960). Soflaei et al. (2017) worked on the impact of courtyard design variants on shading performance in hot-arid climates of Iran. They conducted a numerical investigation to determine shaded and sunlit areas of courtyards to find out correlation between geometrical properties and orientation with comfort temperature. Their results show that the courtyard's design variants have considerable influence on the shading performance of courtyards and consequently on residents' thermal comfort.

Despite courtyards are well-known for their passive energy efficient forms, there are few research which specifically focus on traditional courtyard houses in Iran, as one of the oldest civilizations in the world that go back to 3000 BC (Edwards et al., 2005). Therefore, this study goes further to fulfil this gap through analyzing the environmental concept of traditional courtyard in hot-arid climate of Iran, to develop a design model for courtyard, as a passive cooling strategy, in contemporary sustainable residential buildings.

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