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# Passive control methods for a comfortable indoor environment: Comparative investigation of traditional and modern architecture of Kerala in summer

A.S. Dili [a,*], M.A. Naseer [b], T. Zacharia Varghese [c]

[a] Department of Architecture, TKM College of Engineering, Kollam, Kerala, India
[b] Department of Architecture, National Institute of Technology Calicut, Kerala, India
[c] Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India

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ABSTRACT

Scientific investigation on traditional architecture of Kerala, that is known for its use of natural and passive methods for a comfortable indoor environment, has been revealing remarkable results recently. Qualitative analysis of the passive methods adopted in traditional buildings and detailed quantitative investigation carried out during all seasons to evaluate thermal comfort have already been reported. As a step ahead, in order to understand the performance of traditional building in comparison with that of modern building, a field study was conducted simultaneously in a selected traditional and a modern residential building during the most unpleasant summer period. The study was conducted by continuously monitoring the indoor and outdoor conditions of both the buildings using a custom made instrument called "Architectural Evaluation System". The results reveal that an efficient passive and natural control system exists in Kerala traditional architecture in providing a comfortable indoor environment irrespective of the outdoor climatic conditions.



## 1. Introduction

The main purpose of a building is to provide an environment that is comfortable, and spoils neither the health nor performance of its occupants [1]. A good indoor environment is important to the success of a building, not only because it will make its occupants comfortable, but also because it will decide its energy consumption and thus influence its sustainability in terms of energy [2,3].

The role of passive controls in reducing the need for high-energy solutions has become important during today's energy-economic crises [4]. Natural and passive cooling method for buildings, can improve indoor environment quality, provide thermal comfort, and reduce energy consumption in buildings. As a result, the study of natural and passive methods for controlling indoor environment has gained more and more attention in recent years [5].

The energy savings using passive and traditional techniques in houses for the purpose of maintaining thermal comfort in comparison with modern techniques are established in many investigations [6–9]. Moreover, the trend towards more efficient architectural designs is pausing challenges to the engineers to provide healthy low-energy design solutions [10,11].

The indoor environment in naturally ventilated buildings greatly depends on the local climate and the way environmental controls are used [12–14]. The building's characteristics influence the impact of outdoor climate and play a major role in controlling the indoor thermal conditions [15]. Studies on passive environment control methods of achieving thermal comfort in buildings and studies for extracting methods and techniques from traditional buildings are in progress in various countries [16–24]. Researches on the aspect of thermal comfort and energy efficiency of buildings are also underway throughout the world [25].

Although, about 48% of the energy consumed in Indian residential buildings is used for providing thermal comfort indoors [26], studies on environment control aspects of traditional architecture have been reported only recently [27–40].

Kerala, located in the southwest coast of India, has a characteristic Warm-Humid climate because of its geographic settings [41]. The presence of high amount of moisture in the atmosphere for major part of the year causes thermal discomfort as there is less evaporation, resulting in sweating. Prolonged exposure to such thermal discomfort conditions can create adverse effects including extensive loss of efficiency in work along with physical strain [42–44].

The authors have conducted an investigation on the passive environment control system of traditional architecture of Kerala. A qualitative analysis discussing in detail about the passive concepts adopted in traditional buildings, a quantitative investigation carried out during all seasons to evaluate thermal comfort and a study based on questionnaire survey among the occupants of traditional and modern buildings on the subjective responses of thermal com-

* Corresponding author. Tel.: +91 944 7303875; fax: +91 474 2712023.
*E-mail addresses:* dili_as@yahoo.com, dili@nitc.ac.in (A.S. Dili).

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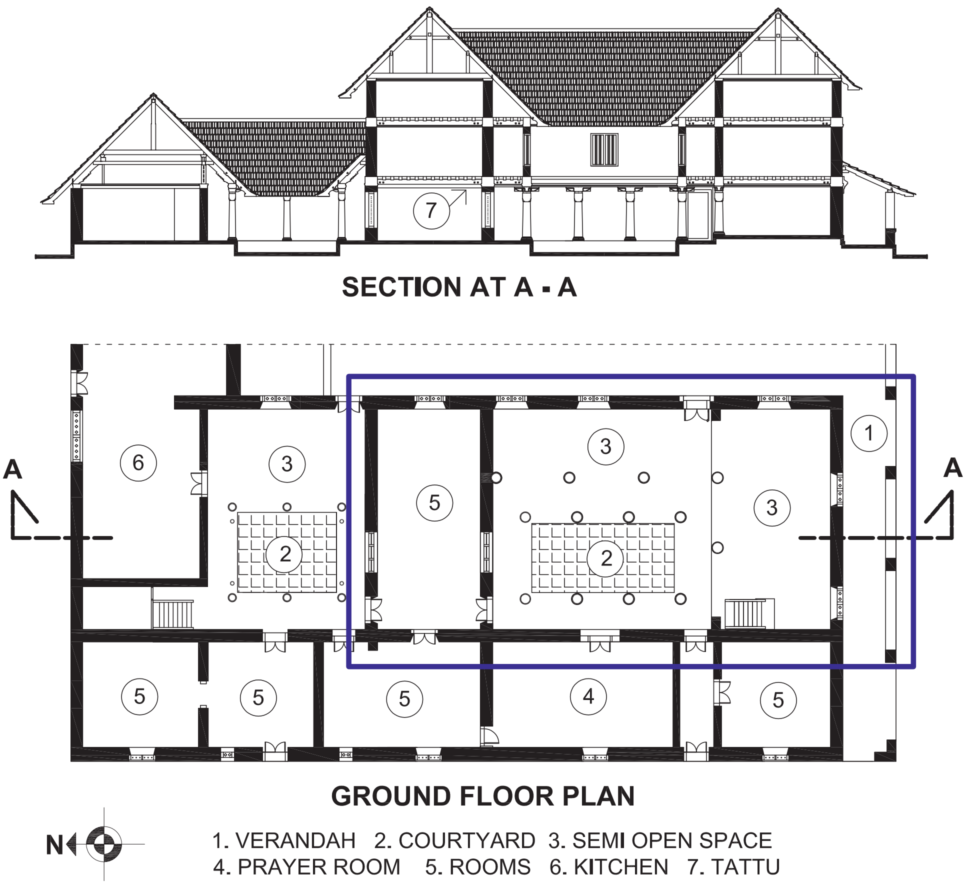


**Fig. 1.** Plan and section of *Puthiya Kovilakam* located at Nilambur – selected area is marked in rectangle [36].

fort have been reported [32–40]. However, it is essential to have a comparative study of traditional building vis-à-vis modern building to verify the effectiveness of such a passive control system. A field study was thus conducted simultaneously in a selected traditional and a modern residential building during the most unpleasant summer period.

This paper presents the passive environment control system of Kerala traditional architecture by analyzing various thermal comfort parameters in comparison with that of modern building.

## 2. Experimental investigation

### 2.1. Building description

#### 2.1.1. Traditional building

Since the design of Kerala traditional residential buildings is based on a modular concept with four blocks built around an open courtyard strictly adhering to the ancient rules pertaining to geometrical grids, proportions and scale, the investigation is confined to a typical traditional residential building in a selected location.

The traditional residential building selected for the study is located at Nilambur in the Malappuram district of the northern part of Kerala. The building (*Puthiya Kovilakam*) is nearly 300 years old. It has three rectangular courtyards in which one courtyard is surrounded by a double storeyed structure while the other two courtyards are surrounded by single storeyed structures. The internal space taken for the investigation is around the courtyard of 1.83 m × 3.66 m surrounded by double storeyed structures. The courtyard has an inward looking verandah of 1 m width. Two sides of the courtyard are semi open spaces that are used for living. The other two sides are provided with rooms having windows and doors opening to the courtyard. The average room height of the building is 2.1 m. Plan with selected area for the study marked and a section of Puthiya Kovilakam located at Nilambur is shown in Fig. 1 [36].

#### 2.1.2. Modern building

In order to have a logical comparative analysis, the modern building was also selected from the locality of the traditional building. The residential building selected for the study is located at the south-west side of *Puthiya Kovilakam* at a distance of 50 m. The 26 years old building "*Shinnu*" has two bedrooms with other activity spaces arranged as shown in Fig. 2. This building has more or less the most common layout that is generally seen in modern houses. This single storeyed building is constructed with the modern materials i.e., 20 cm thick walls of brick masonry plastered with cement mortar and roof of reinforced cement concrete (RCC). The roof has a slope of 10° towards the north and south side for easy drainage of the rain water. The average room height of the building is 3.2 m.

A bedroom of size 4.2 m × 3.6 m located at its North-West side (marked in Fig. 2) is selected for the investigation. The bedroom has two windows of size 1.7 m × 1.5 m each, one on the northern side and other on the western side as shown in the figure. The windows are provided with shades projecting 60 cm from the wall for protection from sun and rain.

### 2.2. Experimental setup

The authors have devised an instrument setup called Architectural Evaluation System (AES) with electronic sensors (to record air temperature, mean radiant temperature, relative humidity and air movement), data logger, memory module (to record data from