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The Efficiency of Using Different Outer Wall Construction Materials to Achieve Thermal Comfort in Various Climatic Zones

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Abstract

The traditional vernacular architecture that is based on natural construction materials such as clay and stone is the most effective way to achieve thermal and climatic comfort inside different architectural spaces. Despite their efficiency, these natural materials are deficient when building large-scale and high-rise buildings. These materials also need periodic maintenance to protect buildings from construction collapse, especially clay structures.

After the industrial revolution, the architectural movement shifted towards high-rise and large-scale buildings through using artificial materials such as cement, steel and glass. These materials demonstrate mass production and quality in implementation, but they are not sustainable in terms of thermal comfort in most climate zones across the world.

It would thus seem sensible to integrate the two types of construction materials, by using a skeletal system for the building made of concrete or steel, which guarantees the structure, and by using natural materials like clay or stone for the outer walls, which assures thermal and climatic comfort in the indoor spaces.

The aim of this paper is to analyse a new construction method that combines the two different construction materials – natural and artificial – to discover which outer-wall material is more effective in terms of thermal comfort in different climatic zones by using simulation programs.

The study constrains the concrete skeletal structure system and tests the efficiency of using different outer-wall construction materials to achieve thermal comfort in three different climatic zones.

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Keywords: natural construction materials, thermal comfort, clay architecture, adobe architecture

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1. Introduction

The term ‘vernacular architecture’ relates to architecture without an architect which depend on four main features: the local building material, appropriate building technology, adapting to the climate condition and sociocultural aspects. Nowadays vernacular has become an architectural trend, with a number of architects and researchers working on it to develop material properties and building construction techniques. Vernacular architecture has a major strong point namely the harmonious relationship between climate, architecture and people. [1]

‘Vernacular architecture embodies a plurality of constraints from places where it belongs, in which the use of local materials and techniques is one of the main features, when compared with industrially produced materials.’ [2]. Local construction involves materials such as clay and stone used for a long period since ancient times, these influence the local identity of heritage sites, in addition to their impact on the level of sustainable and environmental issues related to thermal comfort.

After the industrial revolution, industrially produced material such as cement and red bricks were widely used in many counties on a mass-production level, without being concerned with environmental issues. The lack of energy and the increase in its’ cost has led to establishing a sustainable approach to reduce the energy consumption inside buildings.

This paper address a comparison between different filling materials namely, natural and industrially produced materials- to reach the user comfort zone in order to save energy consumption in the cooling and heating processes in different climate zones. It aims to uncover which construction material is better for use in different climate zones in order to be more sustainable.

2. Thermal comfort

‘Thermal comfort is a term that generally regarded as a desirable or positive state of a person. It is used in relation to how warm or cold a person feels and is clearly related to the environment a person occupies.’ [3]. A starting point is the generally accepted basic definition of thermal comfort from ASHRAE (1966) which is now adopted internationally: ‘Thermal comfort is that condition of mind which expresses satisfaction with the thermal environment.’ [4]

Thermal comfort is a subjective assessment by a person expressing their satisfaction with their local thermal environment. In practice, there are many variables that influence the body’s heat balance with the environment, and in turn that person’s perception of thermal comfort. The most commonly used indicator of thermal comfort is air temperature, it is easy to measure and most people can relate to it. However, air temperature alone is not a valid or accurate indicator of thermal comfort or thermal stress. Therefore, the six factors affecting thermal comfort include both environmental and personal factors. These factors may be independent of each other, but together contribute to a person thermal comfort. The environmental factors are air temperature, radiant temperature, air velocity and humidity. The personal factors are clothing insulation and occupant activity or metabolic heat. [5]. Many other factors can affect either the body’s heat balance, or someone’s subjective response. As examples, these might include age, gender, health, culture, climate, season, personal control, past thermal history, and expectations. [6]

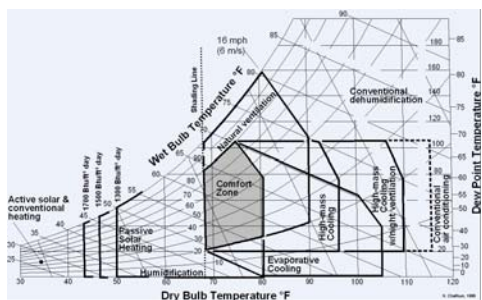


Fig.1. shows Comfort Zone Psychrometric Chart (Reference: <https://ecavelier.files.wordpress.com/2012/12/psychrometric-chart-comfort-zone-7417.jpg>)

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