

Research Paper

Analytical Evaluation of the Thermal Properties of the External Walls of Traditional Rural Dwellings Located in the Foothills of Mazandaran Province

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ABSTRACT

This study aims to analyze the thermal properties of the external walls in the traditional indigenous buildings located in the foothills of Mazandaran Province. The buildings were selected through a simple random sampling method in the study area. Then, a sample of 30 external walls in those traditional dwellings was chosen. They were 60 to 80 years old with an area of 40 to 60 square meters each. The thermo-physical properties of the materials used in the walls were extracted from the Environmental Design Standard (CIBSE) and the Road, Housing and Development Research Center. Then, the octal thermal properties of the walls were calculated using a program that the authors designed by the EXCEL software. Also, based on their octal thermal properties, the walls were all compared in column charts. Eventually, according to the priority and significance of each thermal property, the comparison of the walls was done based on the least and the most energy loss. As the comparative analysis carried out in this study revealed, mud-brick walls have the highest efficiency in terms of Volumetric Specific Heat, Decrement Factor and Time Lag Associated with Decrement Factor. There is a moderate efficiency in other cases, and, in comparison with other external walls, mud-brick walls generally seem to be the most appropriate type of external wall in terms of the criteria in this research. According to the assertions of the permanent dwellers of the traditional indigenous buildings and their rate of satisfaction with the thermal comfort in those places under current climate conditions, mud-brick walls or any other wall with similar thermal properties can be the most appropriate type of external wall in the research area.

Key words:

Thermal comfort, External walls, Thermal properties, Indigenous buildings, Mazandaran

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Extended Abstract

1. Introduction

A

great amount of world energy demand is connected to the built environment.

Energy management is the key factor in any sustainable development program, and reduction of energy consumption in residential and non-residential buildings is one of the main challenges facing any movement toward more sustainable conditions. From 1984 to 2004, primary energy consumption grew by 49% and CO₂ emissions by

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43%, with an average annual increase of 2% and 1.8% respectively. Nowadays, therefore, reducing energy consumption and providing thermal comfort in buildings is one of the major concerns of architects in designing biological spaces. In Iran, energy consumption in the construction sector is extraordinarily higher than international standards. According to the available figures, about 40% of the energy in this country is consumed in domestic and commercial sectors. This is worth about 38% of the total revenue from fossil fuel sales. As much as 70% of this amount is used merely for heating and cooling spaces. According to "the rural eco-museums in *Mazandaran* Province for rural texture improvement projects" which has raised demands for construction in these areas, it is essential to pay attention to the ways of reducing energy losses in building construction. Among the factors that affect the amount of energy consumption and thermal comfort, the role of the external shells of buildings and the materials used in them is significant. In this case study, attempts are made to analyze the external shells of the indigenous buildings in the foothill rural areas of *Mazandaran* Province.

2. Methodology

Mazandaran Province, located in the north of Iran, is a temperate and humid region with about 1.46% of the country's land area. Baliran is a village in the southern district of Amol, which is a county in the middle of the province. The village is a rural foothill settlement which the Organization of Cultural Heritage and Tourism has considered as an eco-museum for rural texture improvement projects. Specific climatic conditions and unique architectural compatibility with the climate are the main reasons for choosing the village of Baliran, along with two other villages of Kimare and Pashakola in its vicinity, as the case study in this paper. The study sample was selected by a simple random sampling method within the study area, and the none-steady state conditions were evaluated as the octal thermal IDs of the materials used in the external shells of the buildings. In order to assess the thermal properties of the walls, a sample of 30 external walls of traditional indigenous dwellings aged 60 to 80 years with an area of 40 to 60 square meters were selected.

3. Results

According to the characteristics of the wall layers, different types of common walls were identified. They are categorized as follows:

a) The most common and widely available type of external wall in the research area is made of wooden logs, as

a prevailing material. The logs are arranged horizontally and joined together to build the walls called "Darvarchin walls". These walls are also covered with a mud mortar on the internal side.

b) Some Darvarchin walls are covered with a mud mortar on both sides, and the outer side is covered with a layer of white sand.

c) Wooden logs are replaced with mud mixed with straw for the construction of the walls. The walls are also covered with a mud and straw mortar on both sides.

d) Mud bricks are used for building some walls. These walls are also covered with plaster on the internal side and a mud and lime mortar on the external side.

e) Baked bricks are used for building some walls. These walls are also covered with a cement-lime-sand mortar on both sides.

f) Baked bricks are used for building some walls covered with plaster on the internal side and a cement-lime-sand mortar on the external side.

4. Discussion

The data on the thermo-physical properties of the wall materials were extracted from the Environmental Design Standard (CIBSE) and the Road, Housing and Development Research Center. Then, the octal thermal properties of the walls were calculated using a program that the authors designed by the Excel software. Also, based on their thermal properties and column charts, the external walls were all compared. Eventually, according to the priority or the significance of each thermal property, the shells were compared in terms of the least and the most energy loss.

5. Conclusion

In rural areas in the foothills of *Mazandaran* Province, among the external walls made of mud-brick, straw-bale, brick types 5 and 6, and wood types 2 and 3, the mud-brick shells were found highly efficient in terms of Volumetric Specific Heat, Decrement Factor and Time Lag Associated with Decrement Factor. The other wall types were found moderately efficient. Generally, as the comparison of the walls showed, mud brick is the most appropriate type of shell in the studied area. This material or any other one with similar thermal properties is considered appropriate enough to be used in wall construction.

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Conflict of Interest

The authors declared no conflicts of interest