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Effect of locations and thicknesses for the different material constituting a building wall

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Abstract

In this study we examine the influence of wall thermal resistance on the building interior temperature using a dynamic regime model. Our computational study is conducted to establish, for a giving wall thermal resistance, how the interior temperature is influenced by the: thermal properties, locations and thicknesses of different materials constituting the building wall. The result of three identical thermal resistance walls, under Fes weather conditions, are Compared.

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Keywords: Thermal resistance, Dynamic regime, Building,Weather condition

1. Introduction

Evaluation the building heat loss is generally based on steady state models. Consequently the thermal inertia of walls is not been considered. Givoni et al [1] suggest that inertia is a necessary recommendation for construction in warm climate to large range. Narayan et al [2] validate the effectiveness of the inertia under cold climate in the creation of thermal comfort and reducing energy consumption. Other studies such as Solange [3], state that the thermal inertia may also be useful in the hot and humid climate.

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This work is attempted to show the interest of considering the energy storage in a room walls with and without energy storage. So, the comparative results for three types of room walls having the same heat resistance are presented.

Nomenclature

C	Thermal capacity (kJ/kg K)
h	Convective heat exchange coefficient (W/m^2 K)
m	The mass of the layer (Kg)
Uv	Global exchange coefficient (W/m^2 K)
t	Time, (min)
a	Absorption coefficient (%)
J	Number of days
R	Thermal resistance (°C m^2/W)
S	Wall surfaces, (m^2)
T	Temperature, °C
Ex	Exterior
Int	Interior
ME	EST wall
cim	cement

2. Description of the building studied

A 15 m² room located in Fez, whose south wall, East, North and ceiling are exposed to sunlight. Taking into account weather conditions of Fez, the overall radiation incident on the vertical and horizontal walls was calculated numerically and the radiation transmitted by the glazing according to their orientation. This first result is validated by [4-5]. The south wall has a 1.68 m² surface of window and 2.68 m² of door surface to the west wall. The thermo-physical properties of materials are giving by the TRNSYS library [6] and literature [7].

3. Analysis and modeling

The numerical study is based on solar and thermal models. The incident radiation on the walls is evaluated using equations reported in [8]. The following hypotheses were considered:

- The day relative humidity is assumed to be constant and equal to 50%,
- The atmospheric turbidity B is equal to 0.1
- The steam saturation pressure of water is evaluated for a constant temperature room,
- The heat transfer in the wall is one-dimensional,
- The internal irradiative heat exchange is neglected,
- The convective heat transfer coefficients are constant.

The 16 heat balance equations concerning the case without energy storage at the building walls room are:

- For externals wall

$$m_i\, c_{p_i}\left(\frac{dT_i}{dt}\right) = h_{ext}\, S\,(T_{ext} - T_i) + a_{cim}\, G\, S + h_{rciel}\, S\,(T_{ciel} - T_i) + \left(\frac{S\,(T_{i+1} - T_i)}{\sum_{n=1}^{4} R_n}\right) + h_{rsol}\, S\,(T_{sol} - T_i) \quad (1)$$

- For internals walls