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Thermal transmittance comparison between multilayer walls made from hollow fired clay and plaster-granular cork bricks using electrical analogy

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Abstract

In this work a comparative study of thermal transmittance between different multilayer walls is examined numerically using the so called Combined Method recommended in the Moroccan standard NM EN ISO 6946/2007. For this purpose a special script was written in Mathematica based on the electrical analogy and where all the thermal transfers occurring across the brick were considered. Tree configurations with and without air gap of 7 cm were compared. The first configuration, concerns walls made of cement render, cement mortar and tree sizes of hollow clay fired bricks (3, 8 and 12 cavities). In the second one, bricks were substituted with those prepared with plaster and granular cork mixes. Finally, in this second case, plaster-granular cork was used instead of cement render. In addition, the compliance with the Moroccan Thermal Regulation of Construction (MTRC) was examined. Results show that in the third configuration, double walls (with air gap) consisting of 8 or 12 cavities bricks are in accordance with all Moroccan climatic zones, leading to overall heat transfer reduction up to 51%.

Keywords: Equivalent thermal transmittance;electrical analogy; hollow clay bricks; composite materials; energy saving;external wall

1. Introduction

Red fired clay hollow bricks, being mainly used to construct building walls, have been long known to accommodate warm homes in the winter and cool dwellings during summer; in contrast, they present several

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disadvantages and occupy a considerable amount of building's energy demand. Therefore many recent researches

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proposed alternatives of the usual bricks, [1] studied the thermal behaviour of hollow clay bricks made up of paper waste and optimized their thermal performance, [2] managed to reduce the total heat transfer occurring across brick walls by 23% through placing clay protuberances inside brick cavities, also [3] improved the thermal inertia of buildings by filling bricks with PCM. The effect of the type of PCM used, its quantity and position inside the brick cavities were then examined. Consequently, this paper propose the use of bricks made of a new composite material plaster-granular cork instead of fired clay bricks, this will not only guarantee a better energy efficiency inside buildings, but will also suppress the environmental pollution resulted from the fired clay manufacturing process.

Nomenclature

R_c	thermal resistance of convection within brick cavity (K/W)
R_r	thermal resistance of radiation within brick cavity (K/W)
R_{ca}	thermal resistance of the brick cavity (K/W)
R_{er}	thermal resistance of external render (K/W)
R_{ir}	thermal resistance of internal render (K/W)
R_{vp}	thermal resistance of vertical partition (K/W)
R_{hp}	thermal resistance of horizontal partition (K/W)
R_m	thermal resistance of mortar joint (K/W)
R_{si}	internal surface thermal resistance (K/W)
R_{se}	external surface thermal resistance (K/W)
R_{up}	upper thermal resistance (K/W)
R_{low}	lower thermal resistance (K/W)
R_g	air gap thermal resistance (K/W)
e_{vp}	thickness of the vertical partition (m)
A_{hp}	vertical partition area (m^2)
N_m	total number of mortar joints
N_c	total number of bricks in the wall
N_{vp}	total number of vertical partitions per brick (three for 8C, four for 12C)
N_{hp}	total number of horizontal partitions per brick
N_{vc}	total number of cavities per column per brick (in vertical direction)
N_{hc}	total number of cavities per row per brick (in horizontal direction)
xC	brick of x cavities
PCM	Phase Change material

2. Materials and method

In order to evaluate the thermal performance of different bricks inside the wall, tree types of hollow bricks (Fig.1) frequently used in Moroccan buildings are studied; coded according to their cavities number. For easy thermal resistance determination, the representing unit cell is consisting of two superposed bricks 8C with joining mortar of 0.01m in thickness on the top and bottom of each brick and between the two bricks, and with external and internal render of 0.02m; represented in Fig. 2 a. Thermal conductivities of basic materials and of the composite material studied; picked from [4, 5], are given in table 1.