ICBMB
International Conference on Bioclimatic Materials & Buildings
Energy efficiency and global industry value chain
3-5 May 2023 in Ifrane, Morocco

Africa-Europe Bioclimatic Collaboration 21
Africa-Europe BioClimatic buildings for XXI century

Creation of a national database on the thermophysical properties of the main locally construction materials and building components in Morocco

Mohamed Ouakarrouch [1,2]*, Najma Laaroussi [2], Saad Raefat [2], Mohammed Garoum [2]

[1] Cadi Ayyad University in Marrakech, National School of Applied Sciences in Safi, MISCOM Laboratory

[2] Mohammed V University in Rabat, Material, Higher School of Technology in Salé, Materials, Energy and Acoustics Team

* Email : m.ouakarrouch@uca.ac.ma.com

Abstract

The main objective of this research study is to create a **national database** of the **thermophysical properties** of the main locally construction in order to contribute to the operationalization of the **RTCM** by feeding the **BINAYATE** Code database made available to users by the Moroccan Agency for Energy Efficiency **AMEE**. The materials concerned are: **plaster, cement mortar, concrete, wood, clay bricks, hollow concrete blocks, zellij, stone, clay, glass, marble, and insulators**. The estimation of the thermal proprieties of these materials was based on standardized experimental methods. Three-dimensional simulations by Ansys fluent software were carried out to characterize the thermophysical properties of clay bricks and hollow concrete blocks at full scale.

Introduction

On a global scale, the building sector is responsible for **28%** of total **energy consumption** and almost **25%** of **GHG emissions**. Faced with this problem, several countries have strengthened their strategy by giving high priority to **energy efficiency**. Morocco is among those countries that have shown their judicious commitment by adopting the Thermal Building Regulations (**RTCM**), applicable mainly to new buildings, and setting, according to the prescriptive and performance-based approaches. However, these performances are intrinsically linked to the **thermophysical characterization** of **construction materials**, in order to determine the most adequate ones in combination with a careful implementation and allowing, in the end, a reduction of the building's energy consumption. In this context, the present work consists in the experimental and numerical characterization of the thermophysical properties of the main **local building materials**, occupying an important place in most of the modern or traditional housing projects in Morocco.

Materials and Methods

Methodological approach

1. Samples preparation
2. Apparent density measurement
3. Heat capacity measurement
4. Thermal conductivity measurement
5. Simulation of clay bricks and concrete blocs
6. Measurement Repeatition and results validation
7. Calibration
8. Results

Characterization methods

Guarded Hot plate method

Differential scanning calorimetry

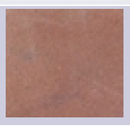
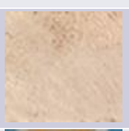
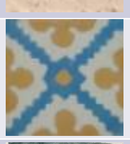
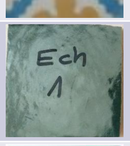
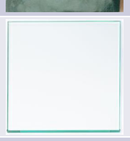
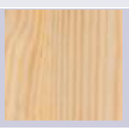
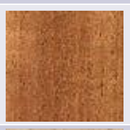
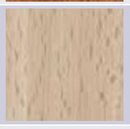
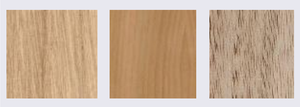
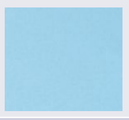
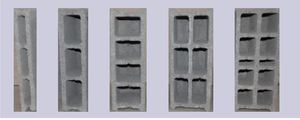
Hot plate method

Flash method

Results and discussion

For the results validation using each method, we studied the repeatability and reproducibility for the determination of the error (standard deviation) according to ISO 5725. The objective is to determine the maximum "acceptable" deviation between two measurements, which should not exceed 5%.

The measured values show the proportionality of thermal conductivity, thermal diffusivity, thermal effusivity and heat capacity with bulk density. However, other factors can influence these measured values, such as chemical composition, porosity, and temperature.

Materials		ρ_{app} (Kg.m^{-3})	λ (W.m^{-1}.K^{-1})	c (J.kg^{-1}.K^{-1})
Concrete		2000 ≤ ρ ≤ 2 300	1.5	890
Cement mortar		1724	0.532	820
Stone		2400 ≤ ρ	3	1500
Plaster		1600 ≤ ρ ≤ 2000	0.59	1010
Unfired clay		1600 ≤ ρ ≤ 2000	1	800
Traditional Zellij		2000	1.05	1150
Zellige tiles		1600	0.54	727
Glass		2300 ≤ ρ ≤ 2500	0.95	810
Marble		2200 ≤ ρ ≤ 2600	3.4	850
Granite		ρ ≥ 600	4	850
Red		436	0.134	2382
Mahogany		639	0.168	1537
Beech		701	0.191	1805
Other		ρ ≥ 650	0.20	1889
Expanded polystyrene		10 ≤ ρ ≤ 30	0.047	1450
Extruded polystyrene		27 ≤ ρ ≤ 28	0.038	1500
Expanded cork		125	0.051	829
Hollow clay brick		585 ≤ ρ ≤ 937	0.35 ≤ λ ≤ 0.46	750
Hollow concrete blocs		923 ≤ ρ ≤ 1369	0.59 ≤ λ ≤ 0.85	810

Conclusion

In this work, we conducted an experimental study on some local building materials in order to establish a national database of their thermophysical properties. The estimation of the thermal conductivity of these materials was based on the steady state hot plate method or the guarded hot plate method with relative error less than 2%. The specific capacities were determined based on the differential scanning method.

The experimentation carried out using the flash method allowed the determination of the thermal diffusivity. The determination of the bulk density of the different samples is based on NM ISO 17892-2.

Acknowledgment

The present research study is part of the $\lambda@_{DB}$ project supported by the **German International Cooperation GIZ** (DKTI IV programme). following a research agreement signed with **Mohammed V University in Rabat** and in partnership with the **National Agency for Energy Efficiency AMEE.**