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ENERGY-EFFICIENT BUILDING USING MANTOSIVA MATERIAL

YOUSIF S. SAEED*, NADA S. ABDULMAJEED ** and SALIH H. NAJIB ***
*College of Engineering, University of Kirkuk, Iraq
** Technical Engineering College, Northern Technical University, Iraq
** * Technical Engineering Department, Al-Fikra Al-Handasia Company, Iraq

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ABSTRACT

Today we live in an era witnessing an increasing demand for energy at a time when the main sources of energy generation have begun to run out. Which is witnessing a significant increase in the amount of consumption, offset by the inability to meet the population's energy needs. It would be beneficial to reduce energy consumption in buildings to a more environmentally friendly level and to a more energy-efficient level, this paper evaluates the Mantosiva material in walls to reduce heating cooling loads. Using (block, brick, Thermostone block) walls and creating the models, which have been simulated by Passive House Planning Package (PHPP) and Hourly Analysis Program (HAP) programs. To do this, image analysis techniques were used, and the analysis of the models was described by the diagram parameters. Six types of walls were analyzed in two programs, Mantosiva was used as a replacement for the external plaster. The objective of this research is to study the effect of Mantosiva material on the energy consumption of buildings in Iraq and identify the amount of energy savings from the application of Mantosiva in buildings. PHPP and HAP were used to calculate the thermal loads and the amount of energy needed. The building is located at Longitude 44.44° and Latitude 35.44° in Kirkuk/ Iraq.

KEYWORDS: Buildings Design, Energy Efficiency, Passive Design Strategies; Sustainability.

1. INTRODUCTION

The issue of energy consumption in various sectors of life, especially the building sector, which represents the largest part of this consumption [1], it has become a fundamental issue that marked as a highly concern by almost all the energy and green building conferences all around the world, including Iraq [2]. The nature of Iraq's climate, represented by two main periods, winter and summer, and the short temperate periods made the use of material reducing energy consumption extensively in buildings, a necessary and important matter to ensure a suitable indoor environment for the occupants, especially in the hot summer period [3]. This led to an increase in the rates of energy consumption in buildings, especially in the last two decades, and this problem represented the general limits of the study, due to the importance of the topic, many studies and research sought to try to find practical solutions that reduce energy expenditures in buildings by controlling the impact the climate affected the building by adopting different strategies.

The reality of energy consumption in Iraqi buildings indicates that most of the energy

yousif.salam@uokirkuk.edu.iq
nst_architect@ntu.edu.iq
Najibsalih@msn.com

consumed is for cooling and heating purposes [4], due to the nature of Iraq's climate, which is distinguished by the large range of hot and cold months, in addition to the changes in the external environment in general, which is known as the global warming phenomenon [5]. Due to of what happened in the recent period with the hole that was found in the ozone layer and the climate change significantly all over the world, companies have competed to produce environmentally friendly materials to reduce environmental pollution while achieving the goals of the development of engineering, one of the most important point is to control the global warming by reducing the use of cooling and heating devices, resorting to thermal insulation works and preserving the internal energy of the buildings and not losing it due to the change in the weather in the external environment [6].

In order to demonstrate the comparison of construction with thermal insulation from the traditional construction method, which did not take thermal insulation into account, Thermal material focuses on the plaster of the Mantosiva brand, which is considered volcanic stones among its main components, which descend within the type of natural porous insulators and because it contains glass fibers [7], it has an appropriate compressive resistance. And as its details and properties are listed in the table in (Fig.1).

Essential Characteristics	Performance	Method of test
Thermal Conductivity,λ10dry.(W/m.K)	T1(≤ 0,1 W/m. K)/0,056	EN 1745,Chart A1/ EN 1745,Item 4.2.2
Reaction To Fire	A1(F90 (Minutes 90)	EN 13501 - 1
Adhesion strength(after 28 days)	(FP)B / 0,2 - 1,5 N/mm2	EN 1015 – 12 (N/mm2 and fracture pattern (FP)A,B or C
Compressive strength (after 28 days)	CS I / 0,4 - 2,5 N/mm2	EN 1015 - 11a
Capillary Water Absorption	W1 / c ≤ 0,40 kg/m2. min 0,5	EN 1015 - 18
Water vapourperneability (μ)	≤ 15 (7.35 μ)	EN 1015 -19 a,b
Dry bulk density (kg/m3)	400 kg/m3 ±%15 kg	EN 1015 - 10
Wet unit density	800 kg/m3 ±%15	EN 1015 - 10
Sound insulation dB	23dB/ 20 db/(3cm/500hz)	EN ISO 10140-2
Joule test	12 (damaged at 2 joule level)	EN 13497

Color/ appearance	White /Granule
Packaging shape	15 kg ±2%/ Kraft Bag
Pallet packing shape	72 pieces / pallet / 12 rows stacking/1.080 Kg
Consumption amount	4 Kg±%15/10 mm for thickness
First Drying time	8 Hours(at 23°C, 50% Relative Humidity)
Full drying time	36 Hours(at 23°C, 50% Relative Humidity)
Drying Time for Testing	28 days at 23°C, 50% Relative Humidity)
Application Temperature	to be applied at +5 /+35°C
Application Duration (Pot Life)	4 Hours (at 23°C, 50% Relative Humidity)
Applicable Thickness	Minimum 10mm, maximum 100mm. Recommended thickness values.
Shelf Life	18 months in dry conditions

Typical values are obtained from the test results of 4x4x16 mortar prism in 23°C and 50% relative humidity conditions. High temperatures shortens the curing and working time, lower temperatures extends the durations.

Fig.(1):- The essential characteristics and performance of the Mantosiva Material [7]

2. MANTOSIVA EXB EXTERIOR THERMAL PLASTER

Mantosıva is "an A1-class non-flammable construction material. It is manufactured from inorganic materials and does not lose its non-flammable quality even at high temperatures such as 1000C, thanks to its refractory qualities" [8]. Made of inorganic materials, Mantosıva EXB Exterior diffuses thermal waves by refracting them thanks to its refractory property, providing efficient thermal insulation [8]. Consequently, it preserves its property at high temperatures and prevents fires from starting and spreading. Mantosıva's lightweight structure is a result of the thousands of open and closed natural air beads it contains. It has a unique sound absorbing property and absorbs, neutralizes and insulates any high frequency impact sound. Its stable chemical structure stops it from chemically reacting with other substances, while its neutrality means that it does not degrade in water or grow mold. Undamaged by microorganisms, Mantosıva neither allows corrosion, nor oxidation to set in [9]. Figure 2 shows Mantosıva's texture.

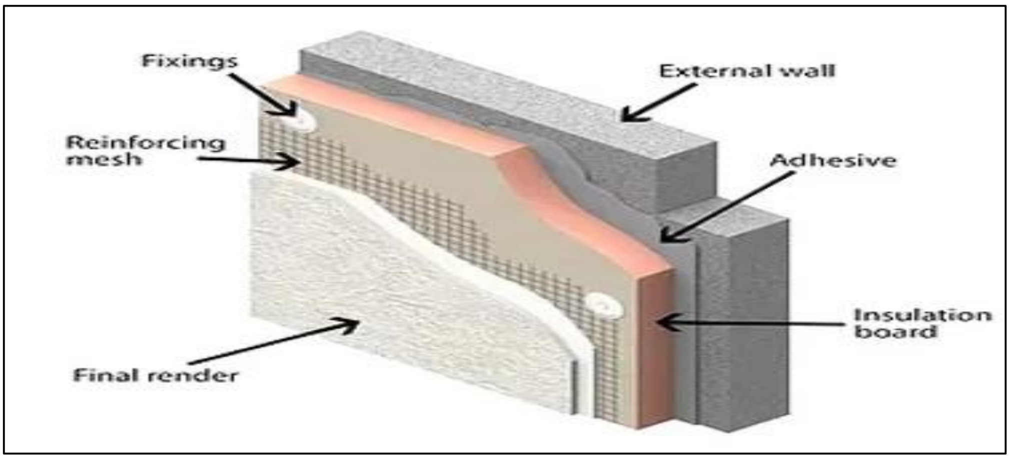

Fig.(2):- Mantosıva Texture [9]

3. KIRKUK CLIMATE AND AVERAGE WEATHER

Figure 3 shows the climate average weather in Kirkuk city of Iraq, the winters are very cold, dry, and partly cloudy however, the summers are scorching, clear, and dry. The temperature typically differs from 41°F to 110°F, Throughout the course of the year [8].

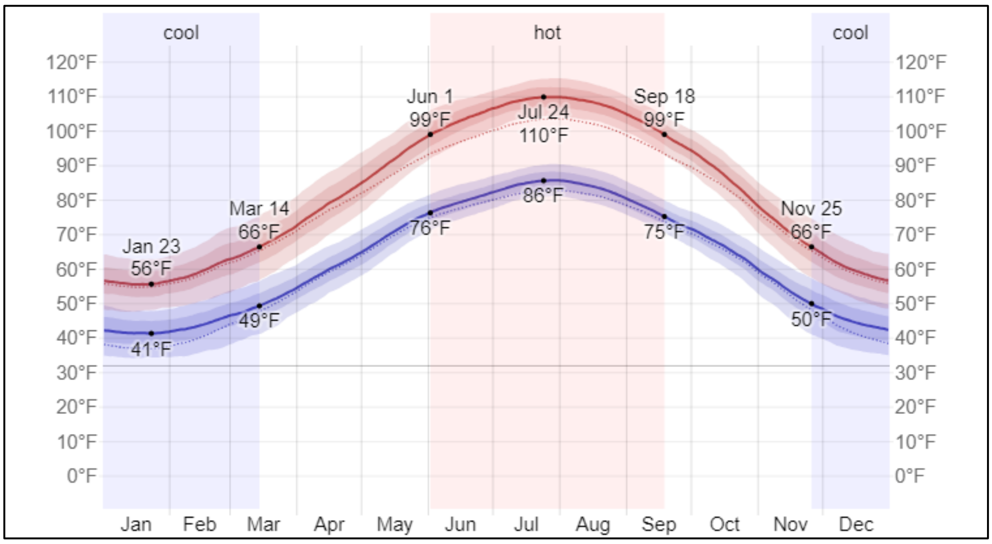

Fig.(3):- The average daily temperature low (blue line) and high (red line) [8]

4. SOFTWARE APPLICATION METHOD

Using software application Passive House Planning Package (PHPP) by the Passive House Institute for the calculation of heating and cooling, which is one of the most powerful design tools available for designing energy-efficient buildings [10]. The calculations are instantaneous, that is, after changing the input, after the creation simulation, the program can immediately see the effect on the energy balance of the building. This makes it possible to compare components with different qualities and thus improve the specific building project in an incremental manner with reference to energy efficiency. All calculations in PHPP are based strictly on the laws of physics.

Where possible, specific algorithms resort to current international standards. The management of methodological variables has also been
) for calculating thermal loads for buildings, a program designed by Carrier International in the field of air conditioning. A program is a powerful tool for designing systems and scaling system components as well as modeling annual energy performance [12].

This step involves extracting data from building plans, assessing the use of the building, and studying Heating, Ventilation and Air Conditioning (HVAC) system needs. Specific types of information required include:

- Climate data for a construction site.
- Building materials data for walls, roofs, windows, doors, exterior shading devices and floors, and interior partitions between air-conditioned and non-conditioned areas.
- Building size and layout data including walls, roof, floors, exposure orientations, and external shading features.
- Data relating to HVAC equipment, controls, and components to be used.

Finally, use the data from the reports created to select the appropriate cooling and heating equipment from product catalogs or e-catalog software.

5. APPLICATION STUDY

To evaluate the effect of Mantosiva material on the energy loads of buildings, a plan (10 x 10) m was created see figure 4, and th
ree types of materials were selected in different plans according to the availability of the site generally used for building construction. The materials used for walls are block, brick, and thermostone use gypsum plaster on the inner side, and to compare the building energy consumption on the outer side, two types of materials are used, plaster cement and Mathosiva, finally created a simulation for each plan. The building model has been assumed and is located in the city of Kirkuk (35.44° latitude - 44.44° longitude).

Fig.(4):- Sample model plan

The floor area of the sample building is 100 m2. The U values of the external building components were given in Table 1. The building is determined as a single-family house. The operating schedule is selected as default and the HVAC system is selected as natural ventilation in PHP and HAP programs.

Table(1):- U-values of the building for various external components

Element	layers of element	thickness (m)	Thermal Conductivity (w/mk)	Thermal resistance (K·m2/W)	Total U-Value for elements (w/m2.k))
wall surfaces Block with plaster cement	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	2.64
	Block wall	0.2	1.3	0.15	
	Plaster cement	0.025	1.5	0.02	
	Ud			0.04	
wall surfaces Block with EXB mantosivat	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	1.22
	Block wall	0.2	1.3	0.15	
	Plaster EXB mantosiva	0.025	0.055	0.45	
	Ud			0.04	
wall surfaces Brick with plaster cement	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	1.49
	Brick wall	0.24	0.54	0.44	
	Plaster cement	0.025	1.5	0.02	
	Ud			0.04	
wall surfaces Brick with EXB mantosiva	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	0.90
	Brick wall	0.24	0.54	0.44	
	Plaster EXB mantosiva	0.025	0.055	0.45	
	Ud			0.04	
wall surfaces Thermostone block with plaster cement	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	0.61
	Thermostone block wall	0.24	0.17	1.41	
	Plaster cement	0.025	1.5	0.02	
	Ud			0.04	
wall surfaces Thermostone block with EXB mantosiva	In			0.13	
	Gypsum plaster	0.025	0.65	0.04	0.48
	Thermostone block wall	0.24	0.17	1.41	
	Plaster EXB mantosiva	0.025	0.055	0.45	
	Ud			0.04	
	In			0.13	
Roof	Concrete, Cast In Situ	0.2	1.046	0.19	0.23
	Air	0.1	0.025	4.00	
	Gypsum Wall Board	0.01	0.65	0.02	
	Ud			0.04	
Floor	In			0.13	

Ceramic Tile	0.01	1.2	0.01	1.52
Concrete, Sand/Cement Screed	0.05	1.046	0.05	
Concrete, Cast In Situ	0.2	1.046	0.19	
Earth	0.2	0.837	0.24	
Ud			0.04	

6. RESULTS AND DISCUSSION

The strategic idea of the design is to find out the difference in the amount of cooling and heating energy for blocks, bricks, and thermostone walls by using cement plaster and EXB mantosiva on the external side.

Table 2 shows wall details and the required energy consumption for both cooling and heating statuses, while figure 4 is the graphical presenting of the required energy for both of cooling and heating, the presented results were obtained using Passive House Planning Package (PHPP) program.

Table(2):- Analysis by Passive House Planning Package (PHPP) program.

Wall Details	Cooling (W)	Heating (W)
Gypsum plaster, Block wall, Plaster cement	6644	2172
Gypsum plaster, Block wall, Plaster EXB mantosiva	6424	2037
Gypsum plaster, Brick wall, Plaster cement	5281	1337
Gypsum plaster, Brick wall, Plaster EXB mantosiva	5207	1292
Gypsum plaster, Thermostone block wall, Plaster cement	4207	686
Gypsum plaster, Thermostone block wall, Plaster EXB mantosiva	4194	678

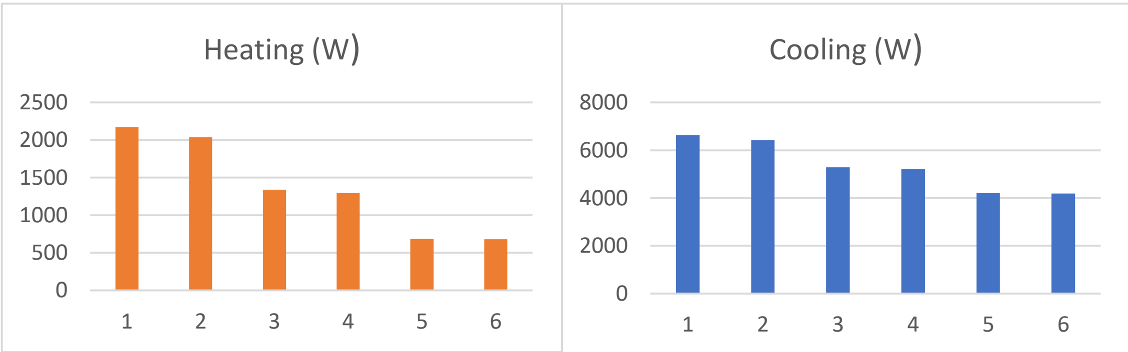

Fig.(4):- Results obtained using (PHPP) program

Table 3 shows wall details and the required energy consumption for both cooling and heating statuses, and figure 5 is the graphical presenting of the required energy for both of cooling and heating in Kilowatts, the presented results were obtained using the Hourly Analysis Program (HAP).

Table(3):- Analysis by HAP program

Wall Details	Cooling (kW)	Heating (kW)
Gypsum plaster, Block wall, Plaster cement	8.80	5.90
Gypsum plaster, Block wall, Plaster EXB mantosiva	7.00	4.80
Gypsum plaster, Brick wall, Plaster cement	6.60	5.40
Gypsum plaster, Brick wall, Plaster EXB mantosiva	5.30	3.70
Gypsum plaster, Thermostone block wall, Plaster cement	4.70	3.00
Gypsum plaster, Thermostone block wall, Plaster EXB mantosiva	4.50	2.60

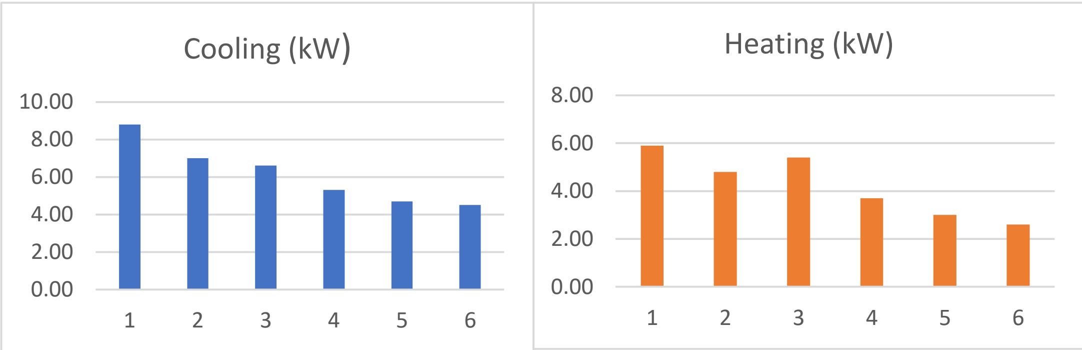

Fig.(5):- Results obtained using (HAP) program

Obtained results using both PHPP and HAP are presented in table 4, it shows almost slightly similar results, however, HAP results shows 1.75% to 1.98% greater than PHPP results.

Table (4): Differences of using both (PHPP) and HAP programs

Wall Details	(PHPP) (W)	HAP (W)	Difference
Gypsum plaster, Block wall, Plaster cement	6644	8800	%1.75
Gypsum plaster, Block wall, Plaster EXB mantosiva	6424	7000	%1.92
Gypsum plaster,Brick wall, Plaster cement	5281	6600	%1.80
Gypsum plaster, Brick wall, Plaster EXB mantosiva	5207	5300	%1.98
Gypsum plaster,Thermostone block wall, Plaster cement	4207	4700	%1.90
Gypsum plaster, Thermostone block wall, Plaster EXB mantosiva	4194	4500	%1.93

7. CONCLUSION

Energy studies prove that buildings are among the largest consumers of energy. The results of the study will be useful to architects and building designers who use specific programs to develop more energy-efficient buildings in the future to achieve sustainable community development. The study clearly shows that the environmentally friendly Mantosıva material can be used as building insulation material which reduces cooling and heating energy. It is clear that passive design strategies have an important impact on building energy needs. By using these parameters, it is possible to reduce needs and provide energy efficiency in buildings construction sector in Iraq.

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