Research 2

The impact of integration of new technologyinsulation material phase change material (PCM)

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1
- نحو الحفاظ على هوية المجتمعات العمرانية المغلقة
- المؤتمر والمعرض الدولي مستقبل المجتمعات العمرانية الخاصة (نحو تنمية عمرانية مستدامة)وزارة الإسكان والمجتمعات العمرانية المركز القومي لبحوث الإسكان والبناء

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- The impact of integration of new technology insulation material phase change material (PCM) as insulation material on thermal comfort in residential buildings compared to traditional material
- Faculty of Helwan– Mataria Engineering Research Journal

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- Sustainability of university buildings through building standards (LEED) and how to be achieved.
- International Journal of Current Engineering and Technology.

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- استدامه المبانى الذاكية دور تطبيقات مبادئ الاستدامه للوصول الى التوازن بين التكنولوجيا والبيئه
- Journal of AL Azhar University Engineering Sector

5
- The Role of Sustainable Maintenance to Ensure Sustainability of the Urban Spaces Heritage.
- Journal of Engineering and Applied ScienceFaculty of Engineering ,Cairo University.

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- الصيانة وإعادة استخدام المباني التراثية في القاهرة التاريخية
- Journal of AL Azhar University Engineering Sector

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- Roof gardens in Egypt: fact or architectural fiction
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- Ancient Egyptian Design to Achieve its Function With Different Factors.
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Faculty of Helwan– Mataria Engineering Research Journal
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بحث مشتق من رساله

The impact of integration of new technologyinsulation material phase change material (PCM) as insulation material on thermal comfortin residential buildings compared to traditional material

ABSTRACT:

This study examines Traditional and New Technology Insulation Material such as (PCM) in residential buildings for enhancing the indoor air quality and reducing the energy consumption in hot dry Climatic. Insulation materials can be a cost effective way of reducing the heat and achieve thermal comfort inside building. Hence, improving thermal comfort. It is a new way to design the smart buildings with light weight. It is quite evident from the preceding reviews that the thermal improvements in a building due to the inclusion of PCM depend on the melting temperature and orientation of the building.

Key Words: Thermal comfort, Thermal Insulation, Traditional material, Phase Change Material (PCM), Sustainable Technologies, Energy Consumption, Hot Dry Climate, New technology of insulation, Mineral wool.

تأثير استخدام مادة تكنلوجية جديدة (PCM) كمواد عازلة في تحقيق الراحة الحرارية للمباني السكنية مقارنة بالمواد التقليدية

تتناول هذه الدراسة مواد العزل التقليدية والتكنولوجية الجديدة مثل (PCM) في المباني السكنية لتعزيز جودة الهواء الداخلي وتقليل استهلاك الطاقة في المناطق المناخية الجافة الحارة. يمكن أن تكون مواد العزل وسيلة فعالة من حيث التكلفة للحد من الحرارة وتحقيق الراحة الحرارية داخل المبنى. وبالتالي ، تحسين الراحة الحرارية. إنها طريقة جديدة لتصميم المباني الذكية ذات الوزن الخفيف.ويتضح من البحث أنه تحسين الراحه الحرارية في المبنى بسبب استخدام PCMتعتمد على درجة حرارة ذوبان وتوجيه المبنى.

الكلمات الداله: الراحة الحرارية ، العزل الحراري ، المواد التقليدية ، مواد تغيير الطور (PCM) ، التقنيات المستدامة ، استهلاك الطاقة ، المناخ الجاف الحار ، تكنولوجيا العزل الجديدة ، الصوف المعدني

جامعة حلوان
كلية الهندسة بالمطرية
مجلة البحوث الهندسية

جامعة حلوان
Faculty of Engineering – Mataria
Engineering Research Journal

السيد الدكتور/ هينار أبو المجد
مدرس بقسم الهندسة المعمارية
كلية الهندسة – جامعة ٦ أكتوبر

تحية طيبة وبعد،،،

بالإشارة إلى البحث المقدم من سيادتكم لمجلة البحوث الهندسية بكلية الهندسة بالمطرية – جامعة حلوان تحت عنوان :-

The impact of integration of new technologyinsulation material phase change material (PCM) as insulation material on thermal comfortin residential buildings compared to traditional material

أسماء المؤلفين

- د/ هينار أحمد أبو المجد
- د/ أيمن حسن محمود
- م.م/ دينا خالد أمين

يسعد هيئة التحرير بكلية الهندسة بالمطرية – جامعة حلوان، إحاطة سيادتكم علماً بأن بحثكم قد قبل للنشر في شهر يونيو ٢٠١٧ بمجلة البحوث الهندسيةبكلية الهندسة بالمطرية – جامعة حلوان، و ينشربمجلد رقم (١٥٥) لشهر سبتمبر لعام ٢٠١٧.

وتفضلوا سيادتكم بقبول وافر الإحترام والتحية،،،

مجلة البحوث الهندسية

رئيس مجلة البحوث الهندسية
ووكيل الكلية لشئون الدراسات العليا والبحوث
أ.د/ علاء جمال شرف

كلية الهندسة . شارع منشية التحرير الرقم البريدى ١١٧١٨ المطرية – القاهرة وفاكس : ٢٢٦٣٣٣٨١٣ . داخلى ٢٤٥

The impact of integration of new technologyinsulation material phase change material (PCM) as insulation material on thermal comfortin residential buildings compared to traditional material

Dina Khaled Amin[1]Henar Ahmed Abo El-Maged[2] Ayman Hassan Mahmoud[3]

ABSTRACT:

This study examines Traditional and New Technology Insulation Material such as (PCM) in residential buildings for enhancing the indoor air quality and reducing the energy consumption in hot dry Climatic. Insulation materials can be a cost effective way of reducing the heat and achieve thermal comfort inside building. Hence, improving thermal comfort. It is a new way to design the smart buildings with light weight. It is quite evident from the preceding reviews that the thermal improvements in a building due to the inclusion of PCM depend on the melting temperature and orientation of the building.

Key Words: Thermal comfort, Thermal Insulation, Traditional material, Phase Change Material (PCM), Sustainable Technologies, Energy Consumption, Hot Dry Climate, New technology of insulation, Mineral wool.

INTRODUCTION:

The thermal mass plays a vital role in decreasing the indoor fluctuations temperatures.New technology material in building insulation as Phase Change material (PCM)can use to provide both temperature regulation and additional thermal mass to new existing structures. Thisprovides light weight buildings with the advanced thermal properties of the ircounter parts as well as savings in the amount of energy required to maintain indoor comfort levels.

Insulation Materials for energy efficiency and thermal comfort in buildings reviewsthe advanced building materials applicable for improving the built environment, it reviews detailsthe development of insulation materials advanced and sustainable technologies as phasechange material for application to achieve the perfect thermal comfort in buildings. This search reviews the application of advanced insulation materials, design and technologies in arrange of existing and new residential buildings in hot climates.The Main aim Explores improving energy efficiency and thermal comfort through insulation material selection and sustainable technologies.

It is well known that insulation is the basic solution to a very common problem butlow energy costs have allowed us for too long to give it short shrift. It has not reached to addressthe insufficient thermal coverings of our buildings. Having chosen instead to hook them up withall sorts of high-tech mechanical devices to manufacture artificially tempered livingenvironments no matter the necessity and the energy costs.

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Insulating materials are a tool for the designer and the constructor to achieve high energy efficiency in buildings. The insulation of the walls and the airspace within the walls becomeless and less important with modern systems of air conditioning and heating, you can manage almost any condition. Armed with that unfortunate logic, we spent decades equipping our buildings with the necessary equipment to"manage almost any condition "instead of pursuing solutions that require less mechanical intervention. The major reason for the energy consumption of buildings rises well above that of both the transportation and industry sectors as our nation's number one fuel guzzling beast. [4]

Now all countries are facing major threatsin energy shortages and pollution. And there has been a large number of energy-saving and environmental protection pressure because it is one of the important aspects in the society. Due to the rapid economic growth has led to increased urbanization and including a significant increase in energy consumption in buildings such as the energy used in cool ingand heating inside buildings. Data shows that the building sector contribution toward global energy consumptionis about40%.

New technology materials like a transparent insulation are a properly last development,that they have the advantage of utilizing solar gains together with the decreasing of thermal losses by means of conductivity. However ,remains limited due to their high cost. The attention of environmental friendly building materials is one of the process of enforcing energyconservation and environmental protection and how new technology materials achieve theenvironmental factors, energy consumption and human's thermal comfort in buildings.

For twenty years, insulation materials being one of the most important and interesting for building's problem. It focus about energy consumption and life-cycle analysis. Insulation materials revolve around its embodied energy the re-use options of the material or its safe disposal

Today, new insulation technology materials are effective, however they would save more energy if they used temperature differences between day and night for cooling system. Using mass building as a storage medium is well known. This concept of night-time cooling has already been successfully procee din many construction projects. Energy storage can be achieved through using PC Minsulation materials. PCM can used paraffin or salt hydrates in the range of use being between 20°C and 25 °C.

New Technology materials like: Gas Filled Panel (GFP) Insulation,Nano technology,Phase change materials, bio phase change materials.

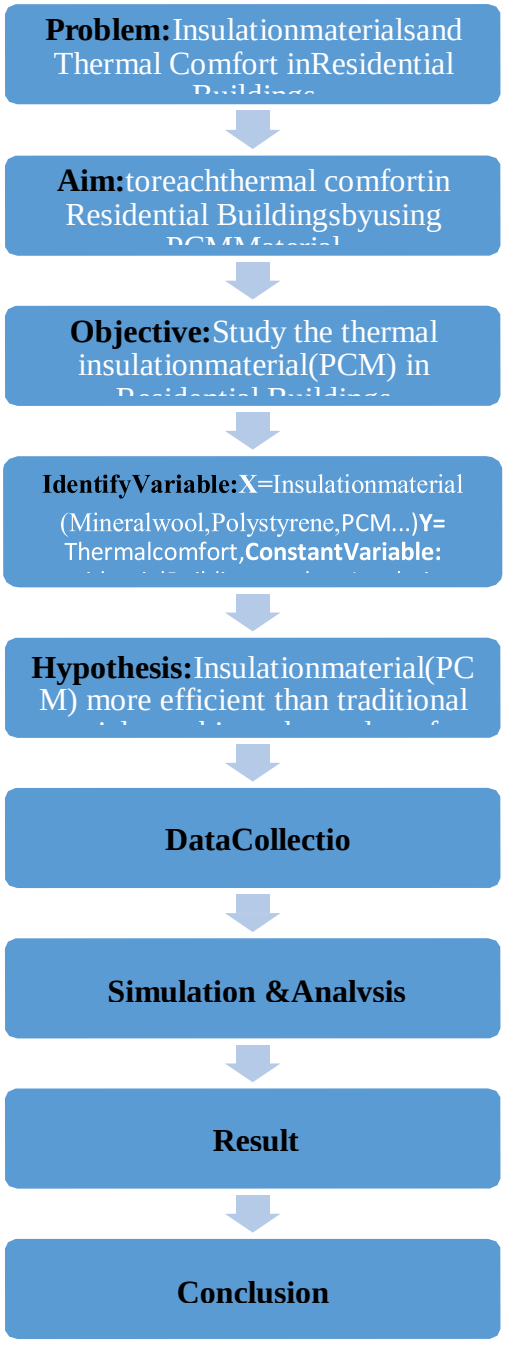
Objective:

The impact of integration of new technologyinsulation material phase change material (PCM) as insulation material on thermal comfortin residential buildings compared to traditional material. The level of thermal comfort depends

on both the environmental dependent variables and personal dependent variables. Thermal insulation material controls play a key role in this action. It controls provide building Protection from high temperature and more comfortable for users .Also energy saving by using insulation materials inside buildings.[1]

Finally, the world pays attention to the fact that insulation materials themselves contribute to green house gase missions and global warming. This happens in two ways: through the embodied energy of the insulation (the energy use and greenhouse gas emissions that resultfrom manufacturing and transporting the material) and with some foam insulation materials through the blowing agents that are highly effective green house gases.[6]

Methodology:



INSULATION MATERIAL ANDMETHOD

Experimental study:

Simulation Method:

1. Insulation materials

-Traditional (Mineral wool)

- New technology material (Phase Change Material)

2. Weather, data collected in the field,surveys and instruments

3.Softwareclimate (Design Builder Program) Method for analysis and compare two insulation material in same conditions and place.

InsulationMaterials:

The study simulates residential building in hot dry climate. Materials data collected; destiny, thickness, thermal conductivity, the software and instruments to conduct the simulation. it used for comparison between two insulation material smineral wool as traditional material and phase change material (PCM) as new technologymaterial.

Data:

Temperature data, climate data, wind speed and relative humidity was collectedfor residential building inEgypt.

Software andInstruments:

In this study data evaluate thermal comfort of buildings by "Design Builder" software which used as an environmental design tool.

> **Design Builder:** is a conceptual design analysis tool and simulation software package by designed the U.S. Department of Energy. It is a software leading provider of Energy Performance Certificate and Building Regulations. The simulation product's design builder provides to designers on energy consumption, thermal comfort for users, carbon emissions andthe status of the building with regard to several national building regulations and certification standards. This program is able to offer considerable expertise in the building energy analysis.

Reasons for choosing this program (Design Builder) Simulation Program:

1. PCM a new technology insulation material and no simulation program has this material.
2. Deign builder has PCM materials in last versions withProperties and characteristics.
3. Included PCM types as BIOPCM , Micronal PCM with all properties.
4. Comparing and results with graphs.
5. Accurate analysis.

INPUT: Design Builder program stipulates the designer a set of environmental performance data like: internal comfort data, climate data zone and energy consumption.

OUTPUT: Results which evaluate by >> ASHRAE 55 comfort criteria standard, Temperature distribution curves, Kansas UniTS V, Pierce Discomfort Index (DISC), ThermalSens.

Weatherdata:

Location: Cairo,Egypt
Climate :Hot dry climate

- It will be included: High temperature, large difference temperatures between day and night causing heatstress, Low relative humidity, A few rain and Strong direct solar radiation.

1. Temperature Range

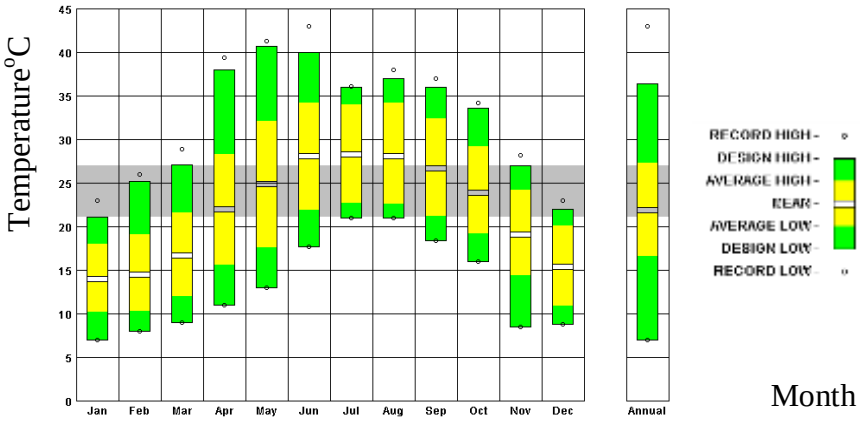


Figure 1.Temperaturerange [10]

In the Temperature Range Fig.١

1. Show the Record ofhigh and low Temperatures (round dots) are the highest and lowest Dry Bulb Temperatures in each month or over the full year.
2. The single bar on the right hand side shows the Annual Design High or Low Temperatures (top and bottomof green bars). They are used to calculate the size of the heating and cooling equipment.
3. The temperature is moderate all the year.
4. Temperature increases in summer resulting in a lack of thermal comfort, therefore high thermal mass and overhangs would be better for the protection of the building in summer.

2. Radiation range:

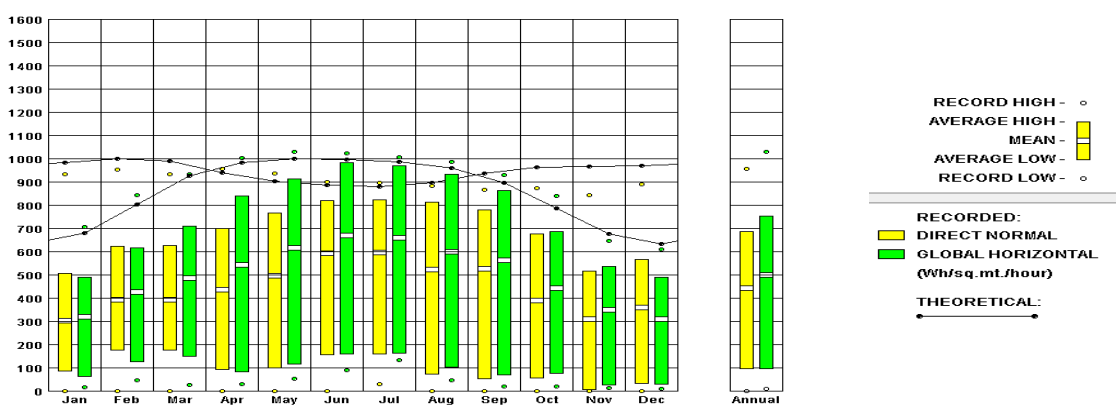


Figure 2. Radiationrange [10]

In Figure 2.Radiationrange

Show The direct normal radiation is less than the global horizontal radiation and this is a resultof the incidenceangle.

3. Wind velocity:

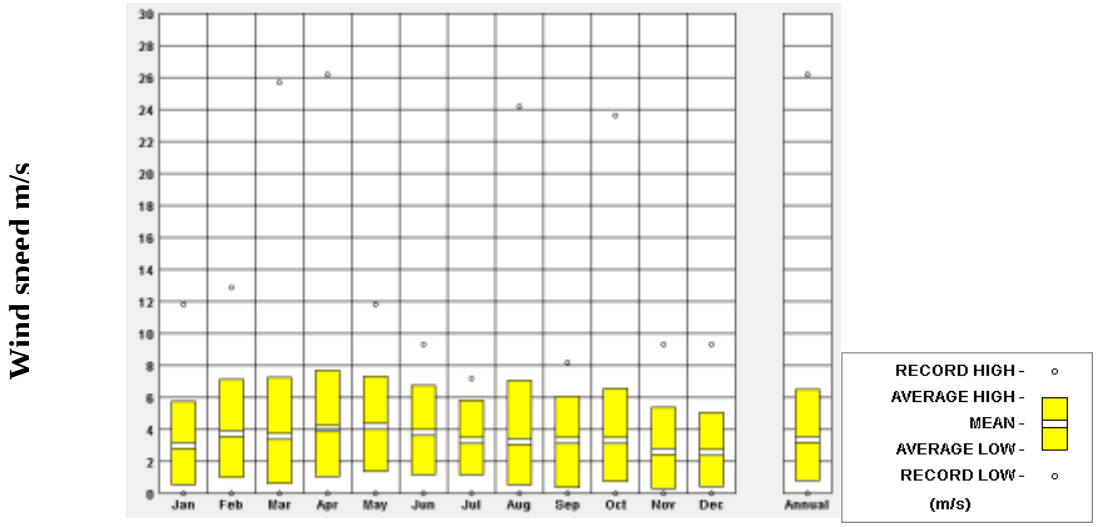


Figure 3. Windvelocity [10]

The figure 3 Windvelocity, Show the wind velocity over the month and year.

4. Timetable plot:

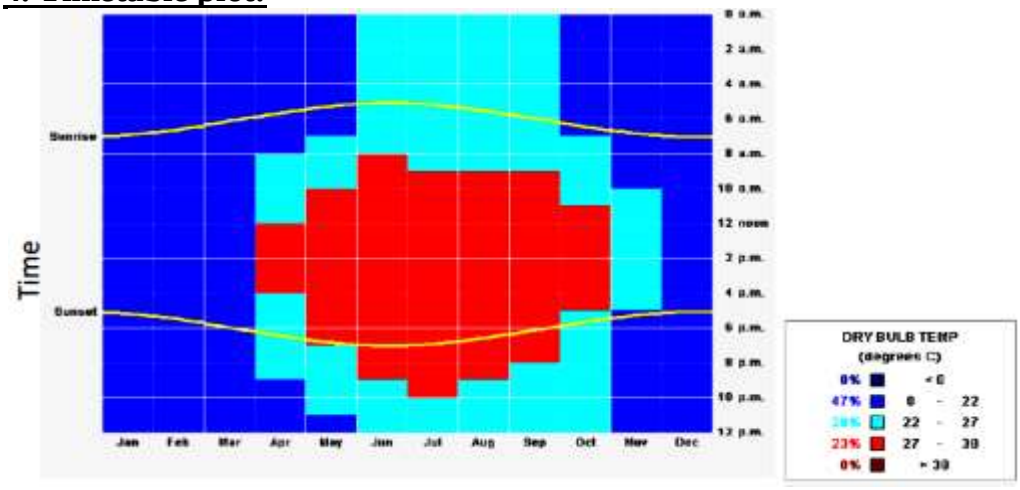


Figure 4. Timetable plot [10]

Figure 4Timetable plot,

1. Shows the months of the year along the bottom
2. The hours of the day along the side.
3. The time when Sunrise and Sunset occurs for each month in this latitude is indicated by the curved yellow lines.
4. Illustrating the temperature filed throughout the year in various day times, in Egypt it does not exceed 38° c.

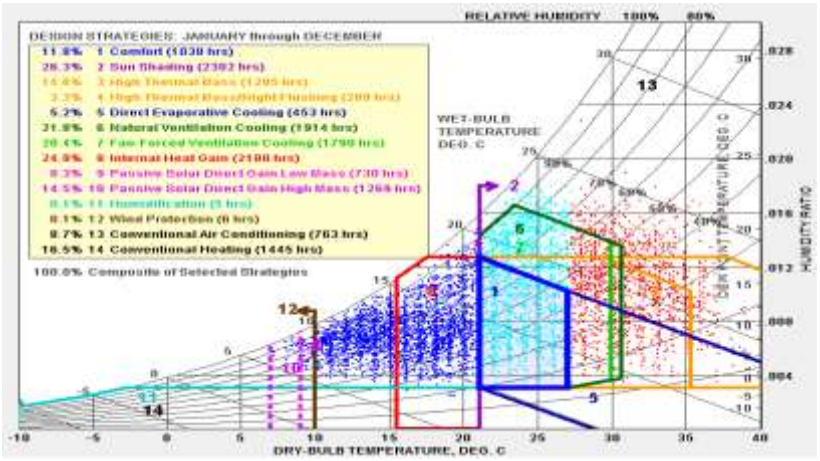


Figure 5. Psychometric chart [10]

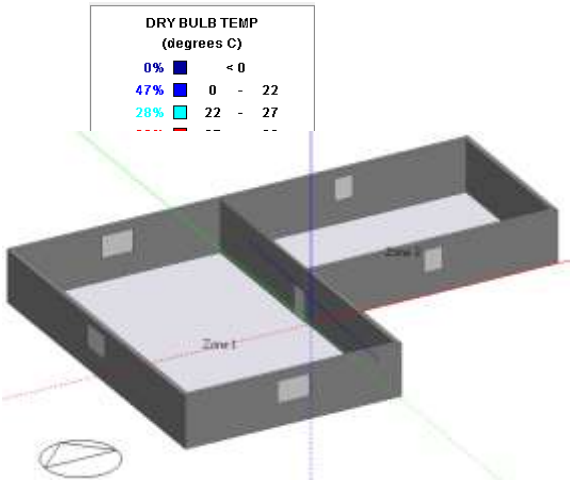
5. Psychometric char

The Psychometric Chart inFigure 5

1. One of the most powerful graphic design tools in Climate Consultant because it not only shows which building design strategies to use but also quantifies how effective each will be.
2. There different ranges of temperature in this region, illustrating the main points must be available in the building to achieve the thermal comfort Simulation:

Methoddescription

The methodology is based on the building insulated analysis with two different insulation materials (traditional and new technology) in Egypt in real climatic conditions.



The procedure is composedof:

1. Preliminary study for climatedata.
2. Data collection of insulation materials.
3. Model design for residential building.
4. Simulation &analysis.

Description of case study:

This case study for residential spaces choosing by North orientation shownin figure 6

- **Case study :** 2 building modelsA,B

Model A: with Mineral woolinsulation
Model B: with Phase Change Material (PCM)insulation

- **Location :** Cairo,Egypt
- **Construction of buildings**: Brick, concrete, plaster, paint.
- **Type of case studies:** Residentialunit.
- **Procedure**

1. Case studyinformation

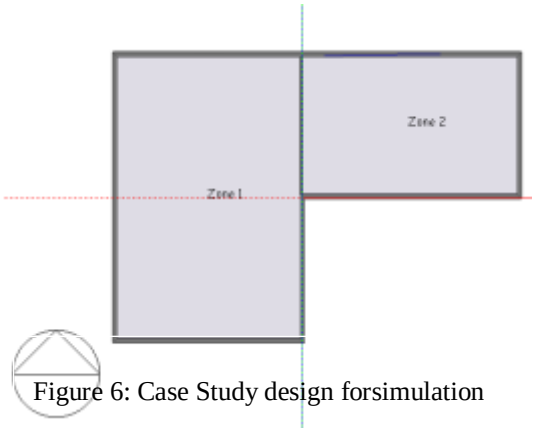


Figure 6: Case Study design forsimulation

Number of spaces: 2 spaces in residentialunit

High: 3.3m

Total Wall thickness: 33 cm

InputData:

Case study mineral wool parameters:

Exterior Walls

Figure 7 show the 5layers of the wall

Layer	Material	Thickness
1	Brick	20cm
2	Mineral Wool	10cm
3	lattice	0.3cm
4	Plaster	2.5cm
5	Paint	0.5cm

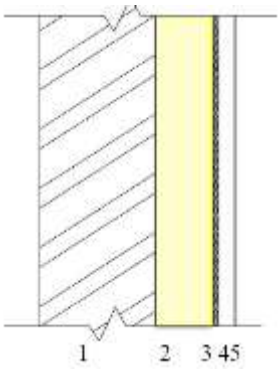


Figure 7.Wall section mineralwood

Floor: 3layers

Figure 8 show LayerMaterial Thickness which is

1	Ceramic	2.5 cm
2	Cement	5 cm
3	Concrete	15 cm

Figure 9 show the layers of the roof

Layer	Material	Thickness
1	Tiles	2.5cm
2	Cement	5cm
3	lattice	0.3cm
4	Mineral Wool	10cm
5	Concrete	15cm

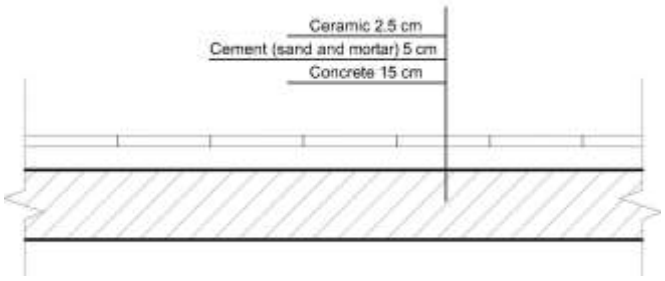


Figure 8.

Opening:

Zone 1: 3 windows Width = 400 cm, Height = 150cm

Zone 2: 2 windows Width = 200 cm, Height = 150cm

Windows 10% from area's space with code standard

Orientation: North

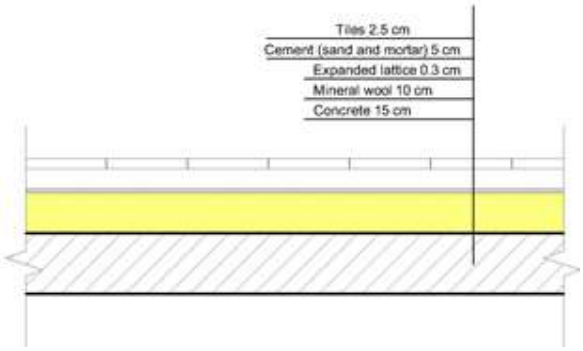


Figure 9.Roof Section for mineral wool

Case study Phase Change Material (PCM) insulation parameters:

Exterior Walls:

Figure 10 show the 5layers of the wall

Layer	Material	Thickness
1	Brick	20cm
2	Bio PCM M91/Q29	3.7cm
3	lattice	0.3cm
4	Plaster	2.5cm
5	Paint	0.5cm

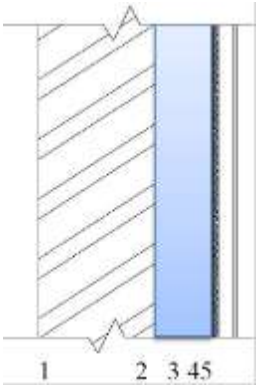


Figure 10.Wall sectionPCM

Floor: 3layers

Figure 11 show the Layer Material Thickness

1	Tiles	2.5 cm
2	Cement	5 cm
3	Concrete	15 cm

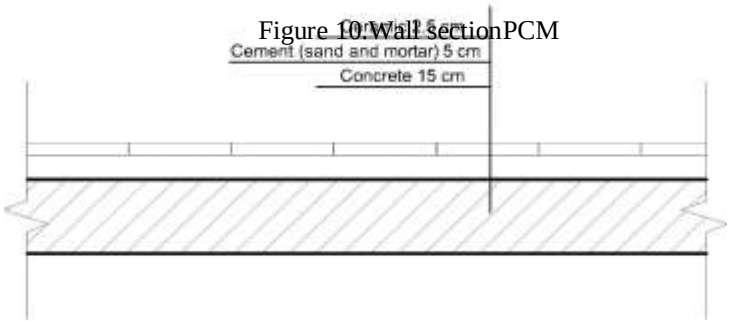


Figure 11.Floor Section for PCM Casestudy

BioPCM M91: is like having a 91 Btu air conditioner during the day and a 91 Btu heater at night for every square foot installed. It has a large thermal energy storage capacity product and the lowest cost per Btu of thermal energy storage capacity.

Roof

Figure 12 show the layers of the roofsection for PCMinsulation

5layers:

Layer	Material	Thickness
1	Tiles	2.5cm
2	Cement	5cm
3	lattice	0.3cm
4	Bio PCM M91/Q29	3.7cm
5	Concrete	15cm

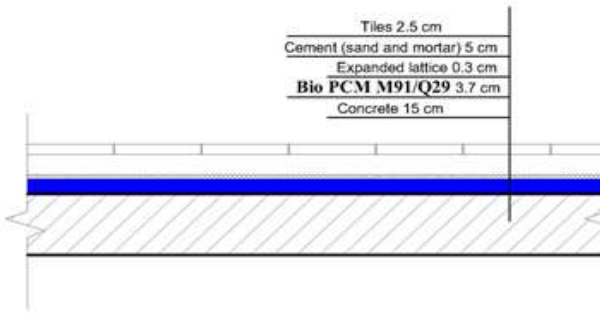


Figure 12.Roof section for PCMinsulation

Opening:

Zone 1: 3 windows Width = 400 cm, Height = 150cm

Zone 2: 2 windows Width = 200 cm, Height = 150cm

Windows 10% from area's space with code standard

Orientation: North

Comparison between Mineral wool and PCM

OutputData: Heating design

Figure 13 and Table.1 show the different between the Temperature and heat loss for Mineral Wool andPCM

Mineral wool:

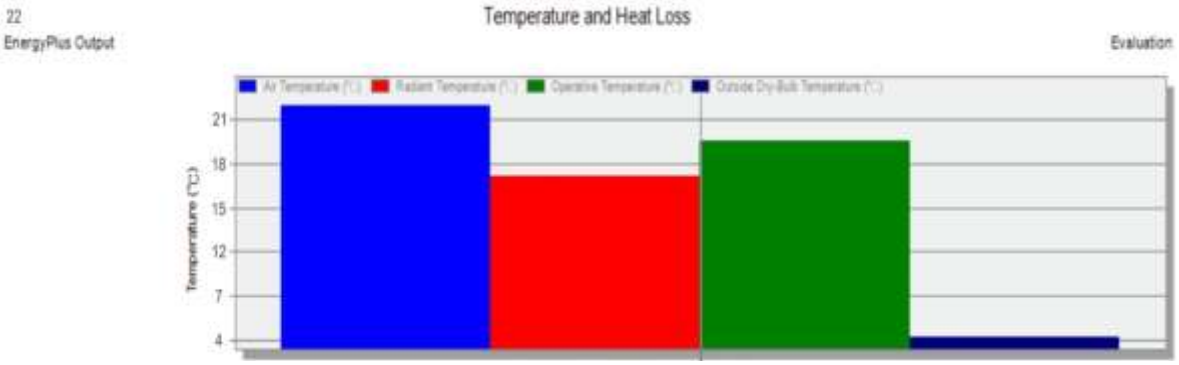


Figure 13. Mineral Wool Temperature and heat loss

PCM:

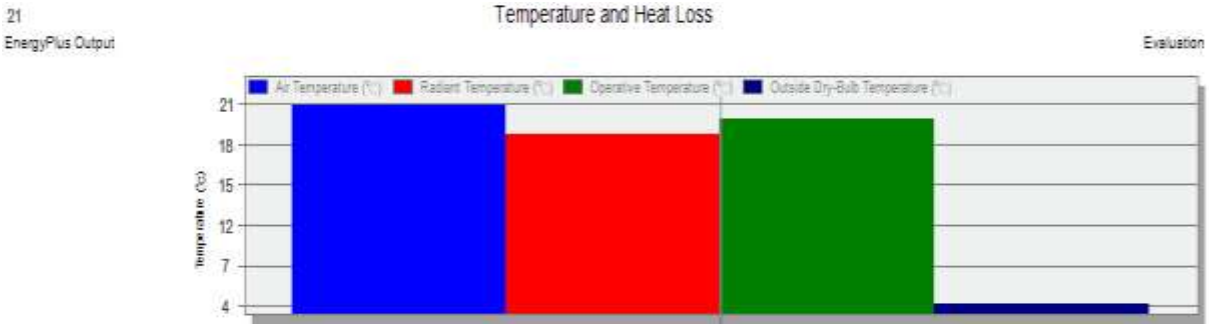


Figure 14. PCM Temperature and heat loss

Insulation	Air	Radiant	Operative	Outside
Mineral wool	24	18	19	5
PCM (^{O}C)	21	19	20	5

Table.1 Temperature and heat loss for Mineral Wool andPCM

OutputData:

Temperature and Heat GainsSub-Hourly

Figure 14,15 show difference between the Temperature and heat gains for Mineral Wool andPCM

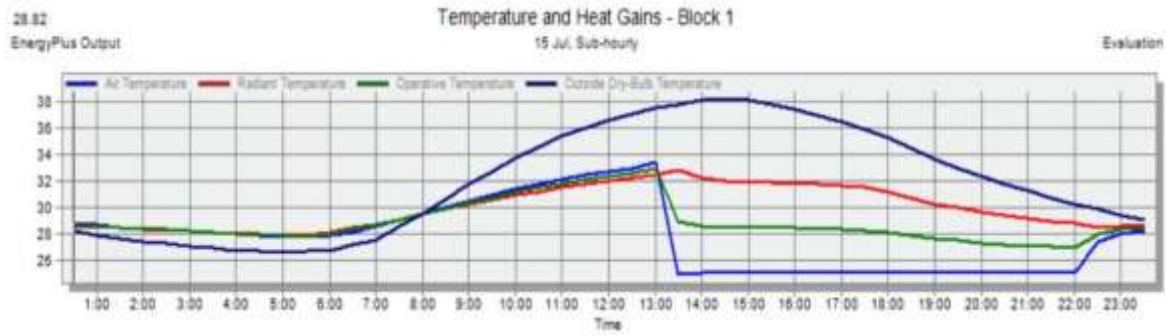


Figure 14. Temperature and heat gains Mineral Wool

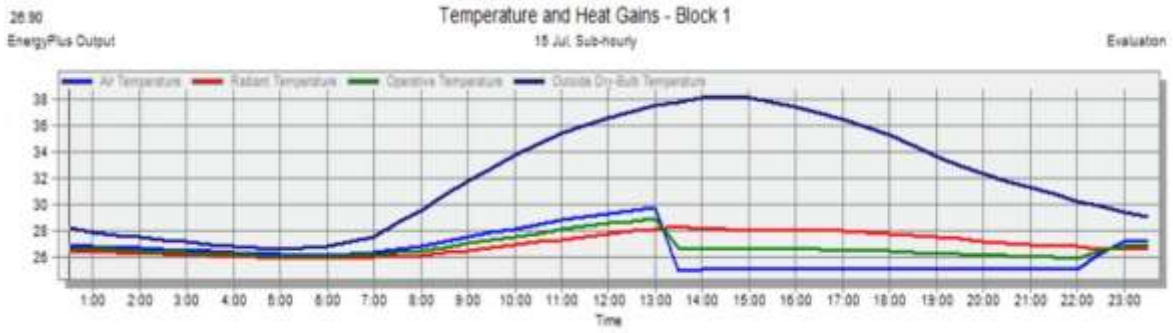


Figure 15.Temperature and heat gains forPCM

Radiant TemperatureAnalysis:

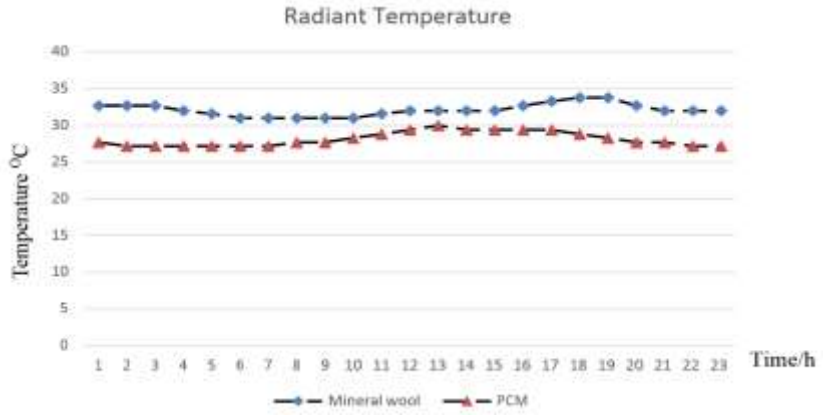


Figure 16.Radiant Temperature

Figure 16 show comparison

-Total average for mineral wool insulation in Radiant Temperature = 32.1^{O}c

-Total average for PCM insulationin Radiant Temperature = 28^{O}c

-Temperature difference between insulation materials =4.1^{O}c

Operative Temperature Analysis:

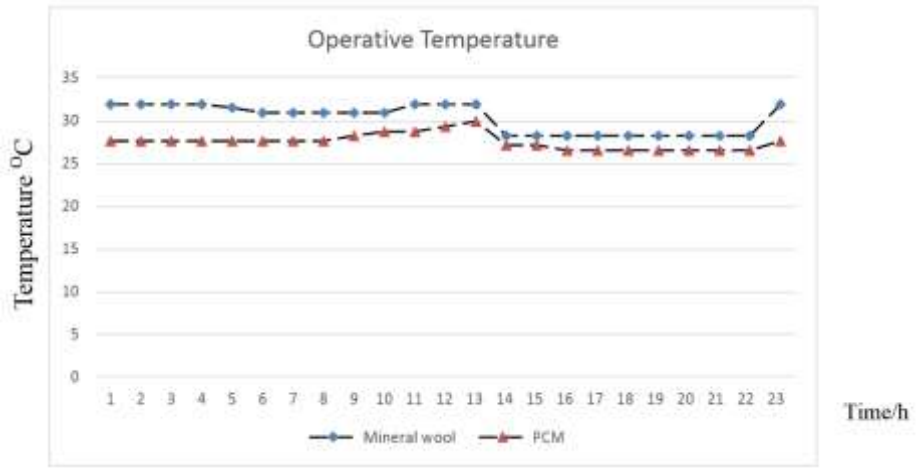


Figure 17.OperativeTemperature

Figure 17.showtheTotal average for mineral wool insulation and for PCM insulation in in OperativeTemperature.

-Totalaverage for mineral wool insulation in Operative Temperature = **30.3^{0}c**

-Total average for PCM insulation in Operative Temperature = **27^{0}c**

-Temperature difference between insulationmaterials =**3.3^{o}C**

Outside Temperature and Air TemperatureAnalysis:

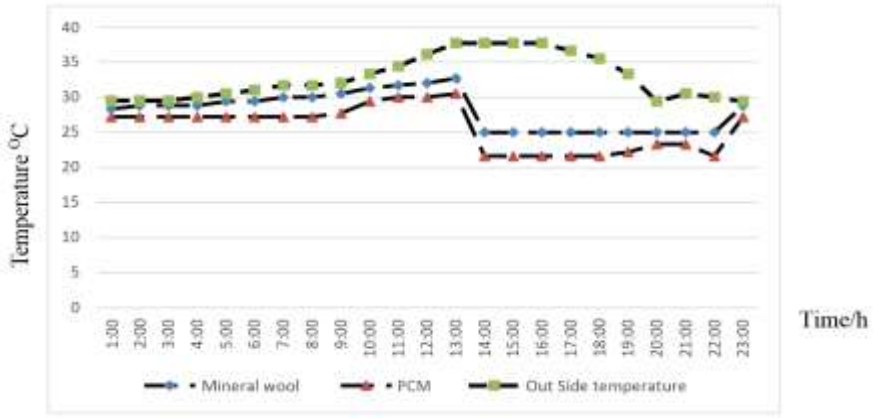


Figure 18.Outside and Air Temperature for insulationmaterials

Figure18.Shown the different between. Outside and Air Temperature for insulationmaterials&PCMinsulation

-Total outside Temperature average for case study =**32^{o}c**

-Total average formineral wool insulation in Air Temperature = **28^{o}c**

-Total average for PCM insulation in Air Temperature=**26^{o}c**

ExampleDaily : (In Different Timing)

1. At 13:00 pm: (The hottest hour in the day) : with outside temperature: 37.7^{o}C

Mineral wool indoor temperature: **32.7^{o}C**

PCM indoor temperature:**31^{o}c**

2. At 8:00 am: outside temperature: **31.7^{o}C**

Mineral wool indoor temperature: **30^{o}C**

PCM indoor temperature:**27.2^{o}c**

3. At 20:00 pm: outside temperature: **29.4oC**

Mineral wool indoor temperature: **25^{o}C**

PCM indoor temperature: **23.3^{o}c**

Conclusion: Which means In Mineral wool insulation Case >>> Air Temperature inside space less almost 4^{o}C. In PCM insulation Case >> Air Temperature inside space less almost 6^{o}C.

System loads for totalcooling:

In Figure 19 and figure20 we see the differen of the system loudfor total cooling betweent Mineral Wool&PCM

Figure 19.Coolingload for MineralWool

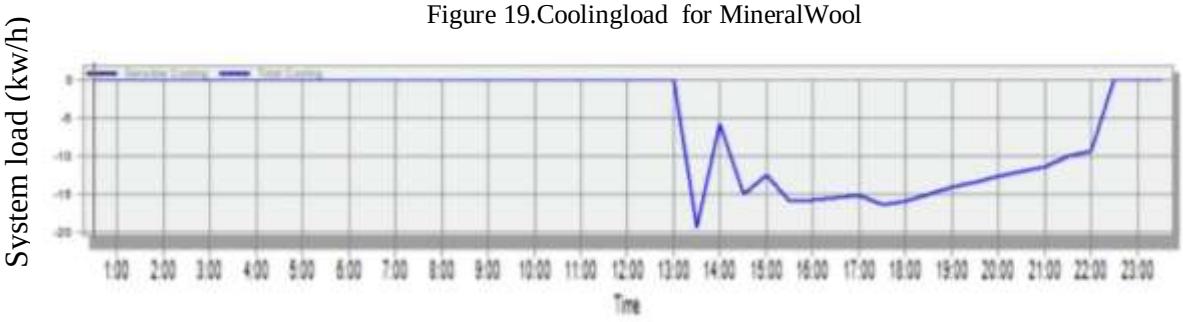


Figure 20.Cooling load forPCM

In table 2 & table 3 showing analysis of cooling load for Mineral Wool&PCM

Table.2 Analysis cooling load for Mineral Wool

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)
Building 1							
Block1:Zone2	13.14	0.8415	11.42	11.42	0.00	25.0	42.4
Block1:Zone1	24.15	1.5468	21.00	21.00	0.00	25.0	42.4

Table.3 Analysis cooling load forPCM

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)
Building 1							
Block1:Zone2	7.23	0.4127	6.29	5.56	0.72	24.9	42.6
Block1:Zone1	15.17	0.8550	13.19	11.51	1.67	24.9	42.7

Total cooling load (kw/h) in mineral wool case = **32.42**kw/h

-Total cooling load (kw/h) in PCM case = **19.48**Kw/h

So PCM insulation Better than Mineral wool insulation in energy consumption

Temperature and Heat GainsDaily:

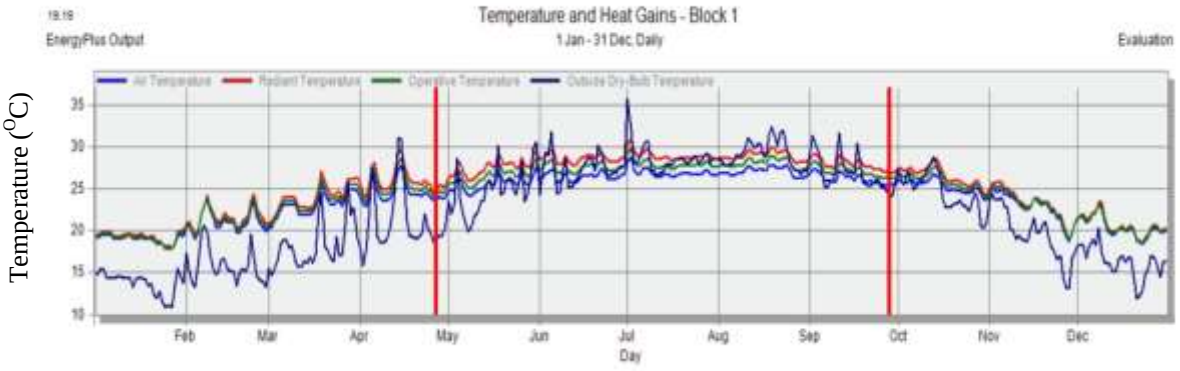


Figure 21.Temperature and heat Gains for Mineral Woolinsulation

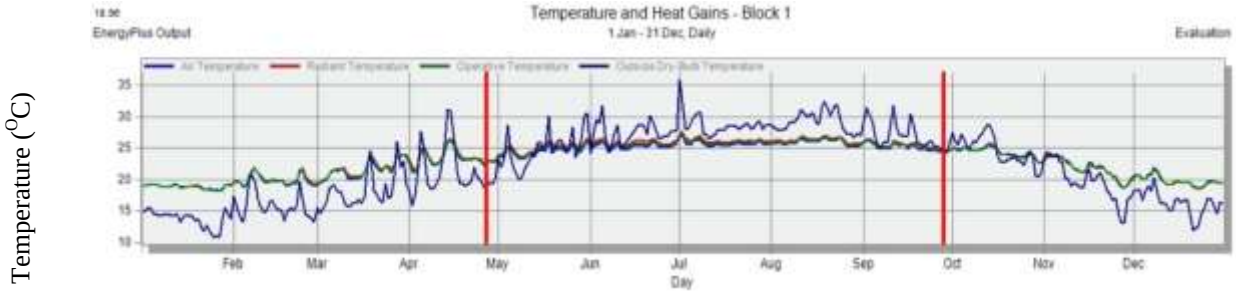


Figure 22.Temperature and heat Gains for PCMinsulation

In Figure 21,22 show difference in temperature system and heat Gains between Mineral wool &PCM

Temperature and Heat GainsDaily: RadiantTemperature

Figure 23 show RadiantTemperature for insulationmaterials

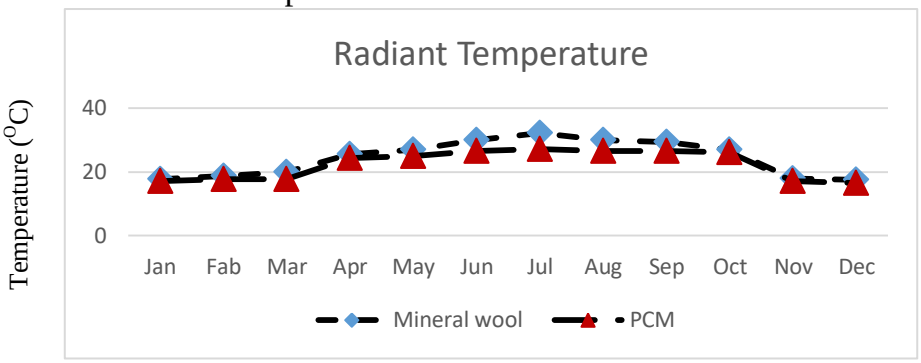


Figure.23 Radiant temperature for insulationmaterials

-Total average for mineral wool in Radiant Temperature =**24.4°C**

-Total average for PCM in Radiant Temperature =**22.4°C**

-Temperature difference between insulation materials = **2°C**

Temperature and Heat GainsDaily:

Operative Temperature

Figure.24 show Operative Temperature for insulationmaterials

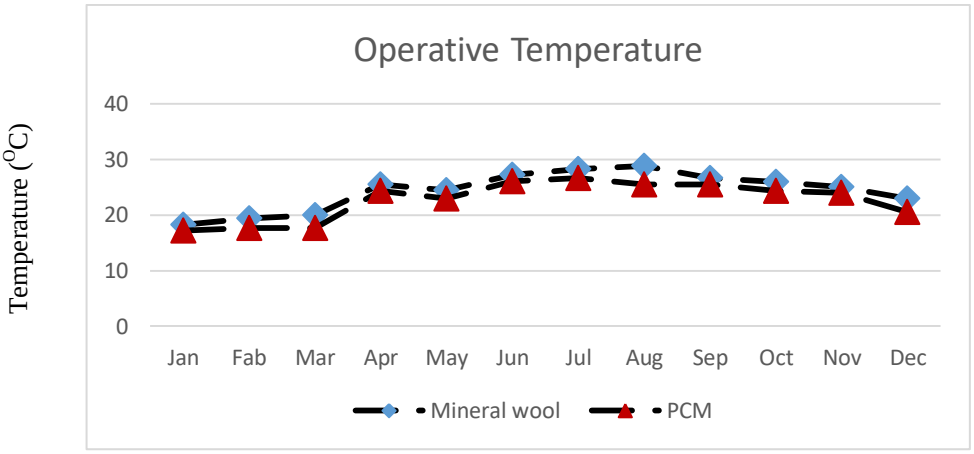


Figure.24 Operative Temperature for insulationmaterials

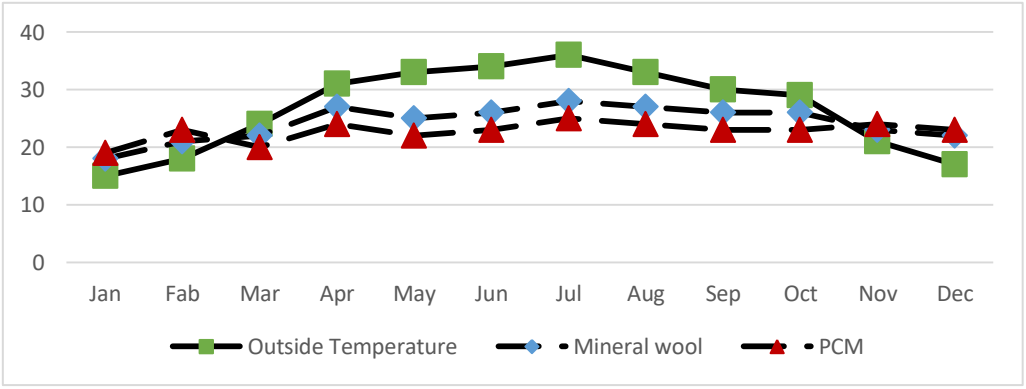
-Total average for mineral wool insulation in Radiant Temperature =**24.4^{o}C**

-Total average for PCM insulation in Radiant Temperature =**22.7^{o}C**

- Operative Temperature difference between insulationmaterials =**1.7^{o}**

Outside Temperature and Air TemperatureAnalysis:

Figure 25.Average Temperature outside for mineral wool insulation and for PCM insulation in air
temperature.



Figure

25.Outside and Air Temperature for insulationmaterials

-Total Outside Temperature average for case study =**26.7^{0}c**

-Total average for mineral wool insulation in Air Temperature = **24.2^{0}c**

-Total average for PCM insulation in Air Temperature=**22.7^{0}c**

***Means In Mineral wool insulation Case: Air Temperature inside space less almost2.5^{o}C**

In PCM insulation Case: Air Temperature inside space less almost 4^{o}C

Example Monthly:

1. On July: (The hottest month in this year) >> outside temperature: **36^{o}C**

Average Mineral wool indoor temperature: **28^{o}C**

Average PCM indoor temperature:**25^{O}c**

2. On September: Average outside temperature: **30^{o}C**

Mineral wool indoor temperature: **26^{o}C**

PCM indoor temperature:**23^{o}C**

3. On January: (The coldest month in this year) >> Average outsidetemperature: **15^{o}C**

Mineral wool indoor temperature: **18^{o}C**

PCM indoor temperature:**19^{o}C**

Conclusion:

PCMmaterialcanbethermalinsulationmaterialinhightemperatureandaheating system in lowertemperature.

Total cooling loaddaily:

In figure26,27showing the different between Total cooling load daily Mineral Woolinsulation and PCMinsulationjnTable.4 we see the Total cooling load for insulationmaterials

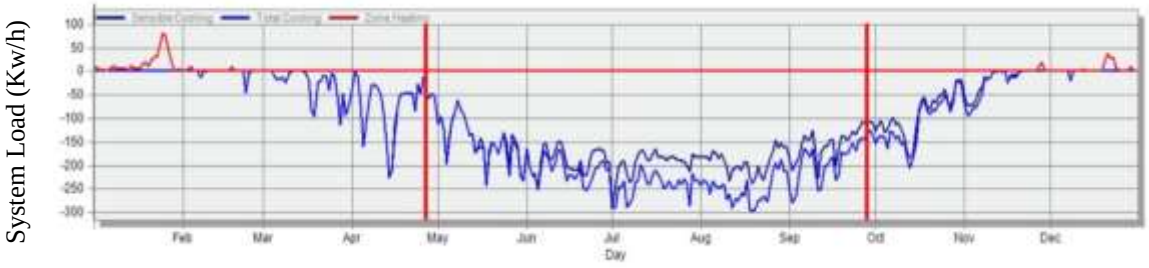


Figure 26 Total cooling loads for Mineral Woolinsulation

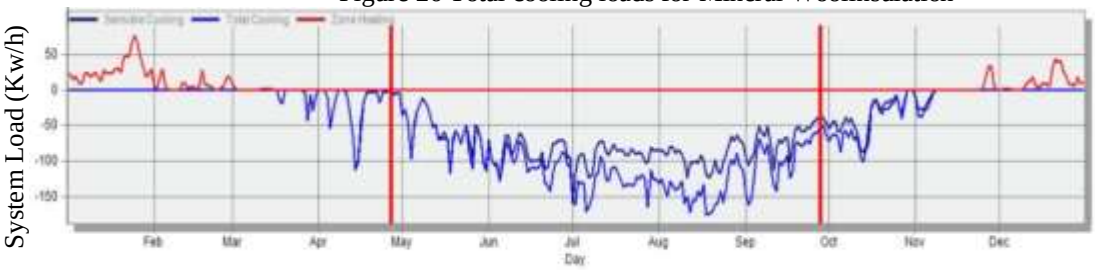


Figure 27.

Total cooling load for PCMinsulation

Insulation Material / Month	Jan	Fab	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mineral wool	0	0	-50	-100	-220	-250	-290	-280	-260	-200	0	0
PCM	0	0	-20	-48	-120	-140	-160	-180	-160	-100	0	0

Table.4 Total cooling load for insulationmaterials

-Average total cooling load (Kw/h) in mineral wool case = **1650 Kw/h**
-Average Total cooling load (Kw/h) in PCM case = **928Kw/h**

Conclusion:

1.Cooling system load in PCM insulation less than Mineral woolinsulation

2. PCM insulation Better than Mineral wool insulation in energy consumptionSimulation for PCM inside building

RESULTS:

1. After Comparison between Traditional insulation material and new technologymaterial Phase change material with 2 simulation programs: Design

Builder 3.4v,PCM express 1.0 based on location, climate data, building structure and used materials. The simulations prove that PCM reduce indoor temperature and achieve thermal comfort inside building.

2. Any traditional insulation materials have a significant impact on the environment, human and the outer space either adversely or does not harm human health or the environment, compared with new technology materials.
3. PCM can integrated in construction building to double the storage of latent heat which make building more insulated and save energy.
4. The impact of new insulation material (PCM) is better than old insulation material such as mineral wool. It reduces the temperature to 2-6 ^{o}C which works to provide better thermal comfort for users.
5. PCM is a technology in building's insulation increase the thermal mass of the building and its resistance to heat absorbs heat during the day and keep them and fired at night to keep warm.
6. PCM can merge with building structure materials such as brick, concrete … and cement blocks which make insulating material an integral part of the building structure.
7. PCM compared with natural materials as: 8cm PCM panel can perform better than a 40cm masonry wall.
8. New technology material (PCM) is better than traditional material (mineral wool) in building insulation where :
   - PCM is thinner and lighter than Mineral wool.
   - PCM Thickness = 3.7 cm of Mineral wool Thickness = 10 cm
9. PCM have a latent heat which convert PCM state from solid to liquid and from liquid to solid.
10. Air conditioning load in mineral wool insulation is more than Air conditioning load in PCM insulation which mean PCM reduce AC using and save energy.
11. There is a difference temperatures between PCM and mineral wool Up to 3- 4 degree Celsius.
12. PCM reduce Carbon emissions and no bad environmental effect as mineral wool.
13. PCM insulation materials in residential buildings reduce the use of (AC) load in summer.

REFRENCES:

[1] Sandhyalaxmi G. Navada, "A Study on Daylight Integration with Thermal Comfort for Energy Conservation in a General office" 2013. Vol.1.no1.india.
[2] Donnelly, Jacqui, 2010."Energy efficeincy in traditional buildings", Science direct.
[3] Obitayo, Olukayode, 2011, "Simulation and analysis of phase change". Science direct.
[4] Benson, Tedd.2012. "The Building Green Guide to Insulation Products and Practices", BUILDING GREEN.
[5] ZhonghaoRao, Shuangfeng Wang, Zhengguo Zhang, "Energy saving latent heat storage and environmental friendly humidity-controlled materials for indoor

climate", Key Laboratory of Enhanced Heat Transfer and Energy Conservation of the Ministry of Education, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou 510640, China, Renewable and Sustainable Energy Reviews 16 3136– 3145,2012.

[6] Papadopoulos, Karamanos, Avgelis, "Environmntal impact of insulation materials at the end of their useful lifetime, Aristotle University Thessaloniki,2000.

[7]Cooling naturally with Phase Change Materials,TROX Magazine, S/PCM/EN/1, www.troxtechnik.com , 2/2009.

[8] Mohammad Taleghani, Martin Tenpierik, Andy van den Dobbelsteen , "The Effect of Different Transitional Spaces on Thermal Comfort and Energy Consumption of Residential Buildings", Faculty of Architecture, Delft University of Technology, Delft, The Netherlands.

[9] http://www.designbuilder.co.uk/content/view /1/12/ 4-2015