

# Performance Analysis of Phase Change Materials in Buildings by Using ANSYS

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**ABSTRACT:** Phase Change Materials (PCM) are organic or inorganic chemical compounds that have large amount of heat energy stored in the form of latent heat which is absorbed or released when the material change its state from solid to liquid or liquid to solid. The PCM retains its latent heat without any change in physical or chemical properties over thousands of cycles. The benefit of a PCM is reduction in heating and cooling loads and in many cases a shift in peak-load demands and the time of day of the peak load. This project investigates the performance and experimental results of studies of partitions containing various phase change materials. The main objective of the measurements was to determine the actual effectiveness of the used phase change materials and their impact on energy storage capabilities through building partitions. The results made it possible to determine the actual effect of PCM applications in partitions on heat accumulation capacity.

**KEYWORDS:** Phase Change Material, Latent heat, energy storage.

## I. INTRODUCTION

The science behind the use of the PCM is fairly simple. As the temperature increases, the PCM storage material changes from solid to liquid phase. The reaction is endothermic, where the PCM absorbs heat. This principle works in the exact opposite when the temperature decreases, the PCM storage material changes from liquid to solid phase [1]. The reaction is exothermic, where the PCM releases heat. "Thermal energy storage can be accomplished either by using sensible heat storage or latent heat storage" [2]. This is beneficial when the daytime surplus heat is absorbed by the PCM melting and becomes liquid, and "when on cooler nights the heat is released back into the building by the PCM freezing and becomes solid again [3]. Different forms of PCM have different melting and freezing temperatures, which can be tailored to suit the application and climatic region of the building.

### TYPES OF PHASE CHANGE MATERIALS [4]

- Eutectics
- Organic phase change materials
- Inorganic phase change materials

### APPLICATIONS OF PCMS [5]

- Building applications
- PCM enhanced concrete
- Thermal energy storage and cooling power potential

### PCM PROPERTIES [6]

- High latent heat of fusion per unit mass, so that a lesser amount of material stores a given amount of energy.
- High specific heat that provides additional sensible heat storage effect and also avoid sub cooling.
- High thermal conductivity so that the temperature gradient required for charging the storage material is small.

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As project analysis is carried out by ANSYS Software by the following steps

- Attach geometry
- Define part behaviour
- Define connections
- Apply mesh controls/preview mesh
- Define analysis type
- Establish analysis setting
- Define initial condition
- Apply loads and support
- Solve
- Review results.

In this work, an attempt is made to study the thermal performance of PCM based building roof for thermal comfort in building. The system has been analysed by numerical simulations by using ANSYS-15 software. The analysis is carried out for PCM based roof with and without weathering course in summer day. In this thermal performance of slabs RCC, RCC+WC, RCC+WC+PCM1, RCC+WC+PCM2, RCC+WC+PCM3 are analysed.

Material Properties

Material	Density (Kg/m <sup>3</sup> )	Thermal conductivity (W/m-k)	Specific heat (J/kg-k)
RCC	2300	1.279	1130
WC	1300	0.25	800
PCM1	850	0.16	1600
PCM2	861	0.4	1850
PCM3	960	0.3	1600

In this work different materials (rcc,wc,pcm1,pcm2,pcm3)and material properties (density,thermal conductivity and specific heat)are used .

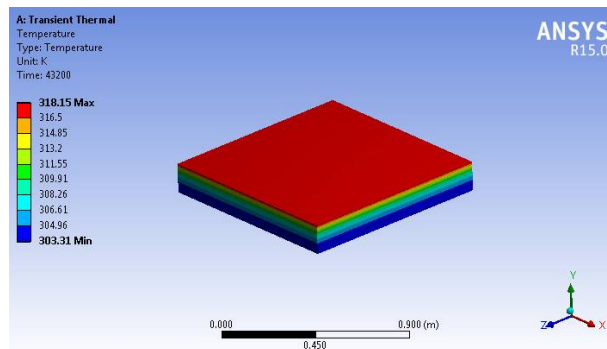
Dimensions of Slabs

Slab type	Length(mm)	Width (mm)	Thickness (mm)
RCC	1000	1000	150
RCC +WC	1000	1000	225
RCC +WC+PCM1	1000	1000	300
RCC +WC+PCM2	1000	1000	300
RCC +WC+PCM3	1000	1000	300

In this work different slabs (RCC, RCC +WC, RCC +WC+PCM1, RCC +WC+PCM2, RCC +WC+PCM3) are considered.

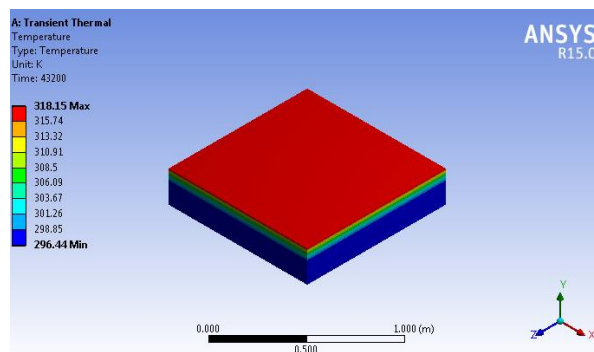
\*RCC -Reinforced Cement Concrete, WC - Weathering course, PCM1-Butyl stearate, PCM2 - Paraffin wax, PCM3- - Stearic Acid.

## II.OBSERVATIONS



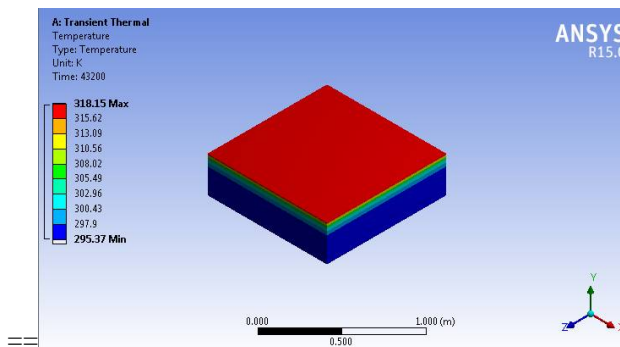
Temperature distributions of RCC at 12 PM (IST)

Temperature distributions of RCC at 12 pm is indicated. At red zone maximum temperature and blue zone minimum temperature occurs



Temperature distributions of RCC+WC at 12 PM (IST)

Temperature distributions of RCC+WC at 12 pm is indicated. At red zone maximum temperature and blue zone minimum temperature occurs



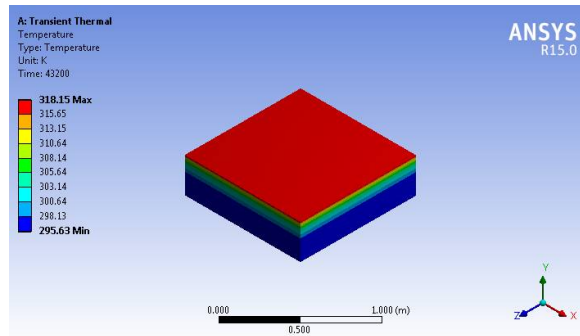
Temperature distributions of RCC+WC+PCM1 at 12 PM (IST)

Temperature distributions of RCC+WC+PCM1 at 12 pm is indicated. At red zone maximum temperature and blue zone minimum temperature occurs

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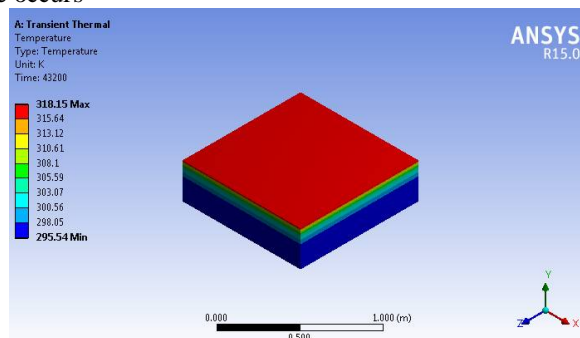
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Temperature distributions of RCC+WC+PCM2 at 12 PM (IST)

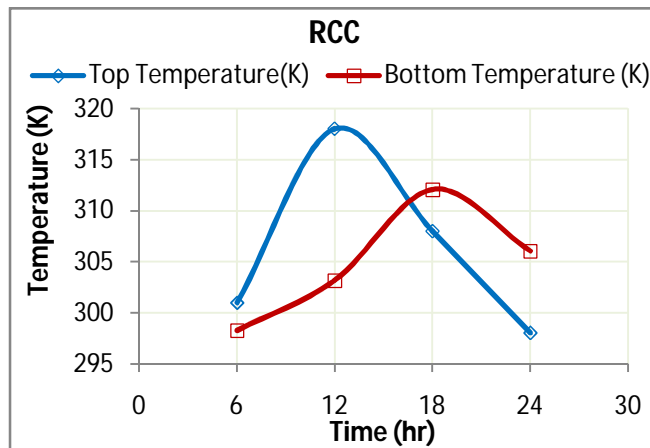
Temperature distributions of RCC+WC+PCM2 at 12 pm is indicated. At red zone maximum temperature and blue zone minimum temperature occurs



Temperature distributions of RCC+WC+PCM3 at 12 PM (IST)

Temperature distributions of RCC+WC+PCM3 at 12 pm is indicated. At red zone maximum temperature and blue zone minimum temperature occurs

### III. RESULTS AND DISCUSSION

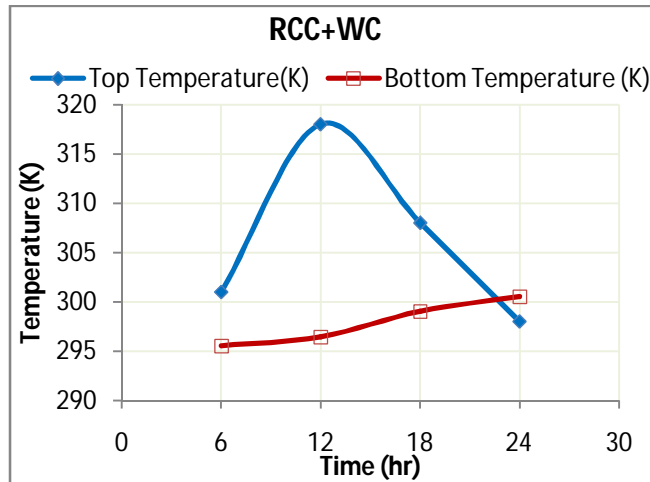


The above graph represents roof top temperature versus roof bottom temperature of RCC. It was observed that the roof top temperature of rcc block is very high.

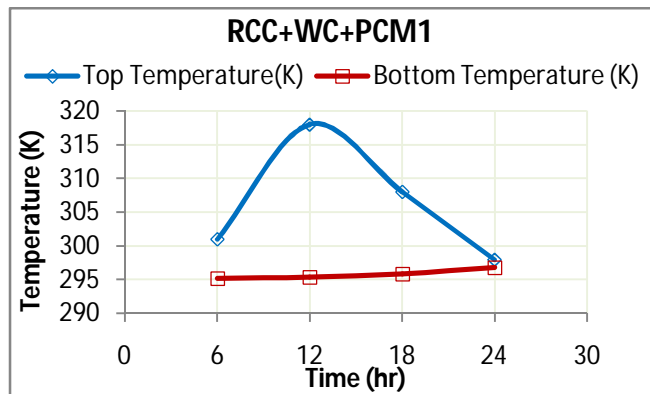
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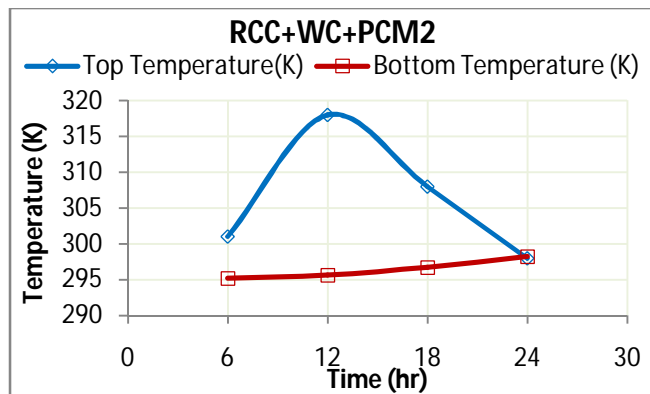
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The above graph represents roof top temperature versus roof bottom temperature after laid WC to RCC. It was observed that roof bottom temperature is low compared to RCC



The above figure shows the graphical representation of roof top temperature versus roof bottom temperature after attaching PCM1 above to composite slab. It was observed that roof bottom temperature decreases compared to RCC

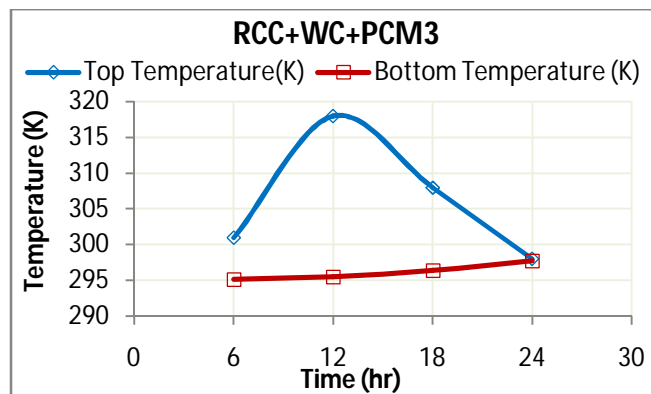


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The above figure shows the graphical representation of roof top temperature versus roof bottom temperature after attaching PCM2 to composite slab instead of PCM1. It was observed that roof bottom temperature is higher by using PCM2 compared to PCM1 [7].



The above figure shows the graphical representation of roof top temperature versus roof bottom temperature after attaching PCM3 to the composite slab instead of PCM2. It was observed that roof bottom temperature is higher by using PCM3 compared to PCM1

#### IV. CONCLUSION

This simulation study on the thermal performance of a phase change material based roof for energy conservation in building is analyzed and discussed. All roofs that are analysed in ANSYS. In this research there are three PCMs are used, PCM1 is best performance compared to PCM2 and PCM3 because of roof bottom temperature observed is low.

#### REFERENCES

- [1] B. Zalba, J. Marin, L.F. Cabeza, H. Mehling, Review on thermal energy storage with phase change: materials, heat transfer analysis and applications, Applied Thermal Engineering 23, 251–283, 2003
- [2] M.M. Farid, A.M. Khudhair, S.A. Razack, S. Al-Hallaj, A review on phase change energy storage: materials and applications, Energy Conversion Management 45, 1597-1615, 2004
- [3] H. Mehling, S. Hiebler, Review on PCM in buildings – current R&D. Paper presented at the IEA Annex 17 Workshop in Arvika (Sweden) held in 8th June, 2004. Available at <http://www.fskab.com>.
- [4] Kenisarin Murat, MahkamovKhamid, Actual problems in using phase-change materials to store solar energy, Paper presentation at the NATO Advanced Study Institute Summer School on Thermal Energy Storage for Sustainable Energy Consumption (TESSEC), C Izmir, Turkey, June 6–17, 2005.
- [5] C. Arkar, S. Medved, Enhanced solar assisted building ventilation system using sphere encapsulated PCM thermal heat storage, IEA, ECES IA Annex 17, advanced thermal energy storage techniques – Feasibility studies and demonstration projects 2nd workshop, 3–5 April 2002
- [6] U. Stritih, P. Novak, Thermal storage of solar energy in the wall for building ventilation, Second workshop, IEA, ECES IA Annex 17, Advanced thermal energy storage techniques, Feasibility studies and demonstration projects, , 3–5 April 2002.
- [7] K. Peippo, P. Kauranen, P.D. Lund, A multicomponent PCM wall optimized for passive solar heating, Energy Buildings 17, 259–270, 1991