

Experimental Study on Heat Transfer in A Reduced Temperature Incorporating PCM in Walls

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ABSTRACT:

To construct comfort ambient temperature in establishment and decrease the usage of air conditioning system in construction, the phase change materials be involved in the proficient character in manage the room temperature. And now a days consumption of vitality factor for functioning of air conditioning system is tolerably high. On the basic of phase change material is integrated in to cement and also there is decrease ambient temperature. Experiment setup was made by two different bricks and PCM. They are Cement Hollow Bricks (CHB), Red Clay Bricks (RCB), Sodium thiosulphate (PCM1), and

Temperature indicator, Bundle of Thermocouple. This two types of bricks is commonly used in building construction. Heat transfer coefficient for cement hollow brick and red clay brick are $0.726 \text{ W/ (m}^2 \text{ K)}$ and $2.2 \text{ W/ (m}^2 \text{ K)}$. Here the PCM is Sodium thiosulphate. It is in solid condition. The thermal conductivity of the PCM is 0.6035 W/ m K . I considered four wall with a height is 60 cm. The first wall is built by Red clay bricks without sodium thiosulphate and the second wall is RCB with sodium thiosulphate pcm. The third wall is made by CHB without sodium thiosulphate and fourth wall is built by CHB with sodium thiosulphate pcm.

Key words : Red Clay Brick, Cement Hollow Brick, Sodium thiosulphate pentahydrate.,

1. INTRODUCTION:

Buildings have attracted worldwide attention due to their high energy consumption in today's relatively energy-poor situation. Energy consumption for air-conditioning is rapidly increasing to create a comfortable indoor thermal environment, which has a detrimental impact on sustainable development. However, the energy consumption of air-conditioning and heating caused by the heat transfer of building envelope accounts for more than 70% of the whole life cycle energy consumption. Improving the thermal performance of the building envelope is a common way to obtain a stable indoor thermal environment and reduce energy consumption. Heavy structures (such as concrete and clay brick) are used as traditional techniques to enhance the thermal stability

of buildings. With the widespread development of lightweight buildings in recent years, traditional methods of heat storage no longer meet the requirements. High indoor temperature fluctuations not only diminish indoor thermal comfort but also increase the energy consumption of air-conditioning. However, phase change materials (PCM) have been concerned as innovative materials for architecture by absorbing large amounts of heat at higher temperatures with small volumes and releasing it at lower temperatures to reach the purpose that suppressing indoor temperature fluctuations.

The objective of this study is to make comfort room temperature in buildings and reduce the utilization of air conditioning system in buildings, the phase change materials play the efficient role in controlling of temperature. And now a day's utilization of energy factor

for operation of air conditioning system is comparatively high. Based on the selection of phase change material the temperature will be controlled in the buildings and here an organic phase change material is incorporated in to concrete and also there is reduction in temperature. The results have to be studied and optimum wall brick materials has to be identified to provide comfort conditions.

Phase Change Materials (PCM) provides a decent solution; the utilization of which in the building envelope promises a reduction in the building's cooling requirements. Lane and Telkes initiated the research on utilizing this material for cooling. Such materials are able to preserve thermal energy in latent heat form until it is released. This enhances thermal inertia and minimizes the demand for air conditioning. PCMs provide many advantages when incorporated into products. They include energy savings, a better night's sleep, cooling and heating relief in remote locations without access to electricity, and better performing electronics. There are two kinds of heat energy: sensible and latent. Applications of the PCMs are used in many different commercial applications where energy storage and/or stable temperatures are required, including, among others, heating pads, cooling for telephone switching boxes, and clothing. By far the biggest potential market is for building heating and cooling.

2 LITERATURE REVIEW:

1 Tung-Chai Ling, and Chi-Sun Poon Use of phase change materials for thermal energy storage in concrete: An overview, *Construction and Building Materials*; **46: 55- 62, 2013**. In this study, Hydrated salt is common material in inorganic phase change material and it has good impact over building applications but due some limitations such as corrosiveness, very high volume change, super cooling characteristic during phase transition and also at liquid state the PCMs goes beyond its freezing temperature then remaining liquid makes the phase change ineffective, so it will not an suitable for concrete applications.

2 In 2012, Boukendil studied the two-dimensional steady state heat conduction, free convection, and infrared radiation coupled heat

transfer calculation of honeycomb walls at room temperature. The results showed that the total heat flux on the wall is almost linear with the temperature difference between the inside and outside. Finally, the total heat transfer coefficient was derived.

3 In 2013, Krajewski studied the heat transfer of a casting riser environment system. The results showed that the heat transfer coefficient of the riser outer surface is affected by the surface temperature and surface emissivity. When the surface temperature is 200–800 °C, the outer surface heat transfer coefficient mainly depends on the surface temperature. When the surface temperature is 1000–1500 °C, the riser surface emissivity changes from 0.28 to 0.42, and the surface heat transfer coefficient mainly depends on the surface emissivity.

4 Cabeza et al. 88 Lleida, Spain studied the maximum temperature reduced up to 1°C and the minimum temperature increased 2°C; the maximum temperature delayed 6 h.

5 Kong et al. 58 Aveiro, Portugal studied the high thermal amplitude reductions of PCM wall specimens M2 and M3 were about 50% and 80%, respectively; time delay of the maximum and minimum temperatures peak increases to 3 h for specimens M2 and M3.

3. EXPERIMENTAL SETUP

The experimental setup consists of a brick wall of size 0.36 m², a bundle of thermocouples, Temperature indicator. The arrangements of the above said parts of the experimental set up are illustrated in the following figure. The dimensions of red clay brick and cement hollow brick is 19*90*90 cm and 40*15*20 cm respectively. They are Cement Hollow Bricks (CHB), Red Clay Bricks (RCB), Sodium thiosulphate (PCM1), and Temperature indicator, Bundle of Thermocouple. This two types of bricks is commonly used in building construction. Heat transfer coefficient for cement hollow brick and red clay brick are 0.726 W/(m² K) and 2.2 W/(m² K). Here the PCM is Sodium thiosulphate. It is in solid condition. The thermal conductivity of the PCM is 0.6035 W/ m K . I considered four wall with a height is 60 cm. The first wall is built by Red clay bricks without sodium thiosulphate and the second wall is RCB with sodium thiosulphate pcm. The third wall is made by CHB without sodium thiosulphate and fourth wall is built by

CHB with sodium thiosulphate pcm.

Figure 3.1 RCB WITHOUT PCM

Figure 3.2 RCB WITH PCM



Figure 3.3 CHB WITHOUT PCM



Figure 3.4 CHB WITH PCM

The system was functioning between 8 a.m. and 6 p.m. In this study, direct measurement are used to keep a measure and record the indoor thermal parameters such as surface temperature, and thermal resistance through the building's surfaces. The measurements were taken in the 15 minutes interval for above experimental setup. The average of 1 h of collected data can be considered for evaluation.

4. CALCULATION AND GRAPH

$$\text{Thermal resistivity (R)} = L \div KA$$

Here area is 1m^2

RED CLAY BRICK WITHOUT PCM :

Thickness of the brick (L) = 0.1 m

Thermal conductivity of RCB = 0.75 W/m K

Thermal resistivity (R) = $L \div KA$

$$= (0.9 \div 0.75)$$

$$= 1.2 \text{ K/W}$$



Thermal resistivity of RCB without pcm = 1.2 K/W

RED CLAY BRICK WITH PCM :

Thickness of the brick (L) = 0.1 m

Thermal conductivity of RCB = 0.75 W/m K

Thermal resistivity (R) = $L \div KA$

$$= (0.9 \div 0.75) + (0.9 \div 0.7035)$$

$$= 2.44 \text{ K/W}$$

Thermal resistivity of RCB with pcm = 2.44 K/W

CEMENT HOLLOW BRICK WITHOUT PCM :

Thickness of the brick (L) = 0.1 m

Thermal conductivity of RCB = 0.5 W/m K

Thermal resistivity (R) = $L \div KA$

$$= (0.1 \div 0.5)$$

$$= 0.2 \text{ K/W}$$

Thermal resistivity of CHB without pcm = 0.2 K/W

CEMENT HOLLOW BRICK WITH PCM :

Thickness of the brick (L) = 0.1 m

Thermal conductivity of RCB = 0.75 W/m K

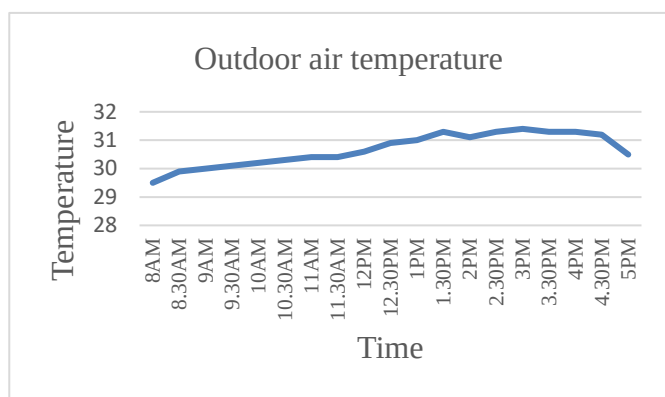
Thermal resistivity (R) = $L \div KA$

$$= (0.1 \div 0.75)$$

$$= 0.34 \text{ K/W}$$

Thermal resistivity of CHB without pcm = 0.34 K/W

GRAPH :



4.1 OUTDOOR AIR TEMPERATURE

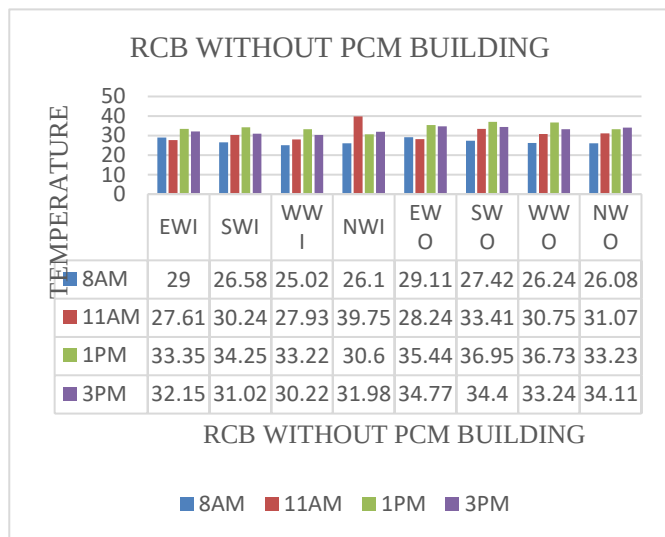


FIGURE 4.2 RED CLAY BRICK WITHOUT PCM BUILDING

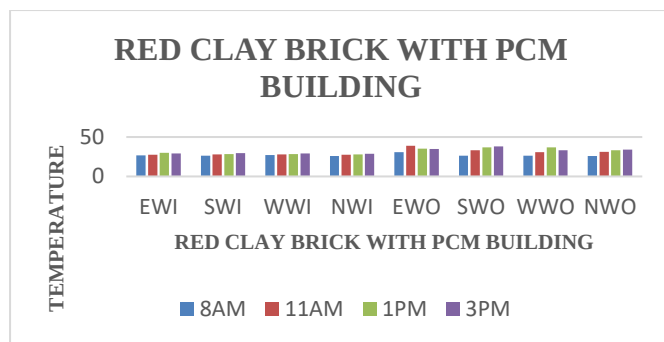


FIGURE 4.3 RED CLAY BRICK WITH PCM BUILDING

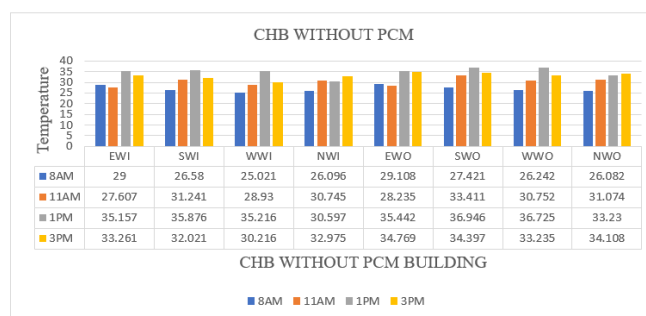


FIGURE 4.4 CHB BRICK WITHOUT PCM BUILDING

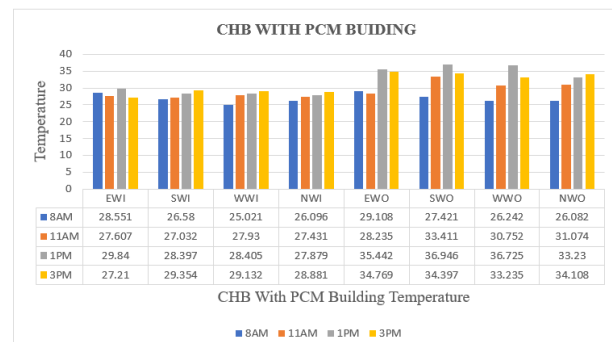


FIGURE 4.5 CHB BRICK WITH PCM BUILDING

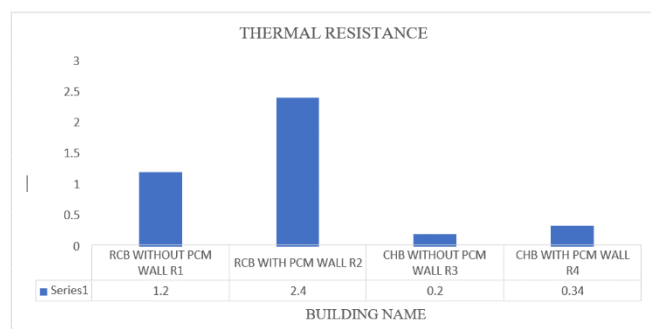


FIGURE 4.6 THERMAL RESISTANCE

5.CONCLUSION

All of the PCM have a good potential for reducing cooling loads by enhancing the storage capacity of the building envelop. However, this storage capacity can be enhanced with an increase of the PCMIBW thermal conductivity.

The major conclusions of this study are listed below

- 1) Sodium thiosulphate has more heat storage capacity. RCB with Sodium thiosulphate mixing cement building is the best reduce inside temperature.
- 2) The core material of phase change material which was incorporated in between wall was efficiently working and there is drop in temperature maximum around 3⁰C to 5⁰C. This helps us to reducing the utilization of air conditioning system.
- 3) Using air conditioners and electric fans to stay cool accounts for nearly 20% of the total electricity used in buildings around the world today. Therefore, by using PCM nearly 20% of electricity can be saved.

FUTURE SCOPE OF THE PROPOSAL :

Increase the thickness of wall how to heat transfer react.

Cement and pcm bonding strength to be measured.
Cement Hollow Bricks are replaced by AAC bricks.

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