Design Energy Saving House by Natural Ventilation in Thailand.

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Abstract

This paper reports the experimental investigation and designing of Energy saving House by natural ventilation. The Gypsum Wall (GW) with to Metal Sheet Roof (MSR). Tinted Glass with Gypsum Wall (TGGW) with to Metal Sheet Roof with Perforated Ceiling (MSRPC). And the Solar Chimney Wall with Daylighting (SC-WD) with to Solar Chimney Metal Sheet Roof with Perforated Ceiling (SC-MSRPC) developed by Faculty Department of Mechanical Engineering, Faculty Industrial Education Rajamangala University of Technology Suvarnabhumi. The experimental study of three test houses. The dimension of the testing boxes is 120 X 120 cm with 120 cm height and the length of roof along slope is 160 cm. The wall houses were made of white painting gypsum board. The GW & MSR is single layer normal metal sheet. The TGGW & MSRPC uses Perforated Ceiling and open void for ventilation. The SC-WD & SC-MSRPC same TGGW & MSRPC but developed panels along the roof degrees. The slope of the angle roof is 30°.The experimental results were showed the room temperature of GW & MSR is always higher than the TGGW & MSRPC and SC-WD & SC-MSRPC, respectively. Observe that, during 12:00 - 18:00 the temperature difference between the attics space with room temperatures from ambient temperature of GW & MSR higher than TGGW & MSRPC and SC-WD & SC-MSRPC respectively due to the effect of attic space cannot ventilated. The average indoor illuminance of SC-WD & SC-MSRPC was higher than the standard illuminance by about 310 -910 lux. The air flow rate and number of air change by about 0.0025- 0.004 m^3/s (9-14 m^3/hr) and 2-8.5 ACH, respectively. The SC-WD & SC-MSRPC should be promoted for architectural and engineering designs.

Keywords: Designing low cost house, Energy saving house, Natural ventilation

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Introduction

Thailand is in a humid tropical climate. This affects the environment almost all year round. Depending on the architectural and engineering design, solar energy is one of the creating effects that will increase the cooling load of a home. Decades ago in Thailand The residence was designed using Solar chimneys to integrate building envelopes to reduce heat transfer and increase ventilation. The Building Science Research Center (BSRC) has proposed a residential performance by reconfiguring the Trombe wall (Khedari J,Pongsathirat C., Puangsombut W., Hirunlabh J.,2005) Renovation of the Trombe Wall (PG-MTW) partial glazing, comprising masonry walls. with glass blocks on the outside Gypsum type aluminum foil and acrylic sheet on the inside. Open the vent of the size PG-MTW was tested against modified Trombe Wall (MTW). Results suggest that it is used in residential homes to reduce heat transfer and luminance in the home, after that BSRC offered homes using solar flue walls (GSCW) (Chantawong P., Hirunlabh J., Zeghmati B., Khedari J, Teekasap S., Win M. M. 2006) consist of double glazing with Air gap area and vent openings at the top and bottom of the glass Test results obtained Confirmed to be suitable for countries with hot and humid climates. There is an increased rate of ventilation. In the summer of 2009, a performance test was conducted. The operation of the Solar Chimney Window (SCW) has been Installed on the school building (Puangsombut W.,2009) SCW consists of glass louvers on the outside. Inside is a clear glass pane which The gap between the glass is 0.065 m. By comparison, two types of louvered glass (clear glass and translucent glass) were used in the exterior. The inner sheet is also clear glass. The results of the experiment were confirmed in use. Solar chimney ideas for home improvement SCW optimization by installing Curtains in the gaps between the air gaps. Between the two model houses using synthetic blinds (Ananacha T., Puangsombut W.,2010) and natural hemp curtains (Watchrodom N., Puangsombut W.,(2010); Sakdapipanich S., Puangsombut W.,2011) SCW was presented with synthetic blinds comprising exterior louvered glass and inside is clear glass, surface area is 0.77 sq m, air gap area is 0.065 m, test results can be Reduce room temperature and ventilation by approximately 2.5 °C and 55 m^3/h SCW with hemp curtains. Nature was monitored for reducing heat transfer and ventilation. Research results show that high efficiency for heat dissipation, giving you the comfort of your home. by fact Various configurations of double glazing panels and theoretical studies and tests (Ananacha T., Puangsombut W., 2012; Ananacha T., Puangsombut W., Hirunlabh J., Khedari J. 2013) show details. Further for the effect of natural light was carried out in the investigation of double clear glass wall (DCGW) and double light glass wall (DTGW) developed by the Faculty of Architecture and Design, King Mongkut's University of Technology North Bangkok (KMUTNB) (Ananacha T.,2014) The study validated the performance of both DCGW thermal configurations consisting of double glazing panels. The outside and inside are clear glass, different from DTGW which the outside is translucen glass The clear glass and translucent glass are the same size, width 60 cm., length 200 cm. and thickness 6 mm., opening the air vents below (inside the room) and above (outside the room). Open the channel to 0.14 x 0.60 m. Test results show that the DTGW and DCGW home illuminance is higher than the illuminance standards by approximately 1,500 lux and 2,000 lux respectively. Air flow rate and amount of air change about 0.0025 - 0.004 m^3/sec (9 - 14.4 m^3/hr) and 2 - 14 ACH, respectively. (Sahabuddin Latif ,(2019) Sahabuddin Latif et al Computational studies using Solidworks Flow Simulation software from heat vents in the attics of traditional Buginese houses in hot and humid tropical climates have been carried out. This research has proposed inclined chimney 45° with horizontal output, to cool the bedroom air for free. The triangular roof of Buginese houses can store large hot stock all day long throughout the year. This solution can improve weather conditions in the attic by modifying how to increase the airflow in it by utilizing the stack effect that occurs due to differences in attic temperature and the environment. In this study, the air intake area is thought to originate from the bedroom window.This flow creates two circulation zones on the inner surface of the roof, which then empties into horizontal channels at the top of the attic. The airflow increases as it passes through the horizontal triangular tube located at the top of the attic. These results present an interesting idea for building thermal energy using a solar chimney system

Human comfort issues in most tropical wellings is the amount of heat from the daily radiation from the sun that enters the house almost all year round Both the roof, walls and other parts that receive solar radiation. Therefore, in response to human comfort, commercial energy is used through electrical machinery such as fans, air conditioners. used to adjust the conditions in the home to be appropriate which will cause a huge waste etc, especially in countries that have to import commercial energy, will result in trade deficits. It also causes environmental pollution problems. This research project will design energy-saving homes based on natural ventilation. This will cause ventilation and reduce the amount of heat entering the building. which is a guideline to study how to reduce building electricity consumption.

Objectives

To study the comparative study of the temperature reduction caused by heat transfer into the building in the design of energy-saving houses by using natural ventilation that can reduce heat entering the building. and ventilate through the building frame in a natural way.

Methodology

The design of energy-efficient houses based on natural ventilation was conducted in small-scale houses to compare thermal performance. The test is in the summer. The mock house for the test shown in Figure.1 is as follows.

Experimental Procedure

Table No.1 Different styles of walls and roofs of 3 model houses.

model house	Wall type	Roof type
model 1	Gypsum Wall (GW)	Metal Sheet Roof (MSR)
model 2	Tinted Glass with Gypsum Wall (TGGW)	Metal Sheet Roof with Perforated Ceiling (MSRPC)
model 3	Solar Chimney Wall with Day-lighting (SC-WD)	Solar Chimney Metal Sheet Roof with Perforated Ceiling (SC-MS-RPC)

Wall and roof tests facing south. The dimensions of the chamber are 1.20 x 1.20 x 1.20 m, as shown in Fig. 2 - 4. The walls and ceiling are using 9 mm thick gypsum. The small test chamber is raised with a steel stand 0.20 m from the floor. Located at Rajamangala University of Technology Suvarnabhumi Suphanburi Center, District 2, on the rooftop of Building 10, 3rd floor, with the coordinates being 13 0 54'N 100 038E.

Figure 1. Shows the house for testing

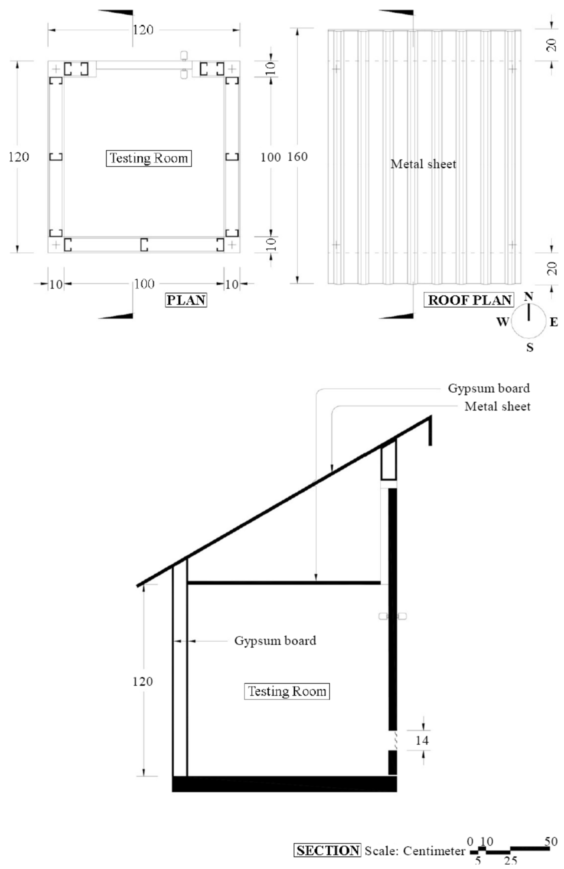

Figure 2. Show Model of the first house, Gypsum Wall (GW) tested together with Metal Sheet Roof (MSR)

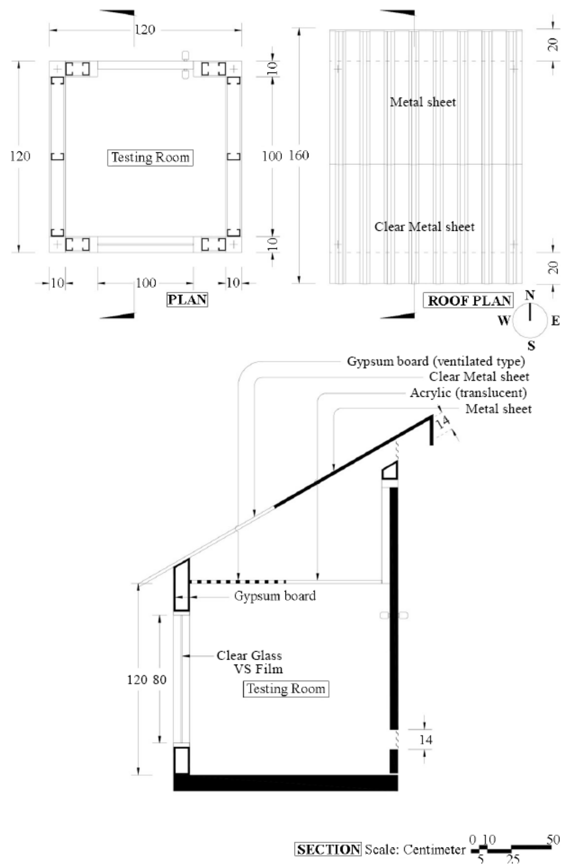

Figure 3. Show Model 2 house model, Tinted Glass with Gypsum Wall (TGGW) tested together with Metal Sheet Roof with Perforated Ceiling (MSRPC)

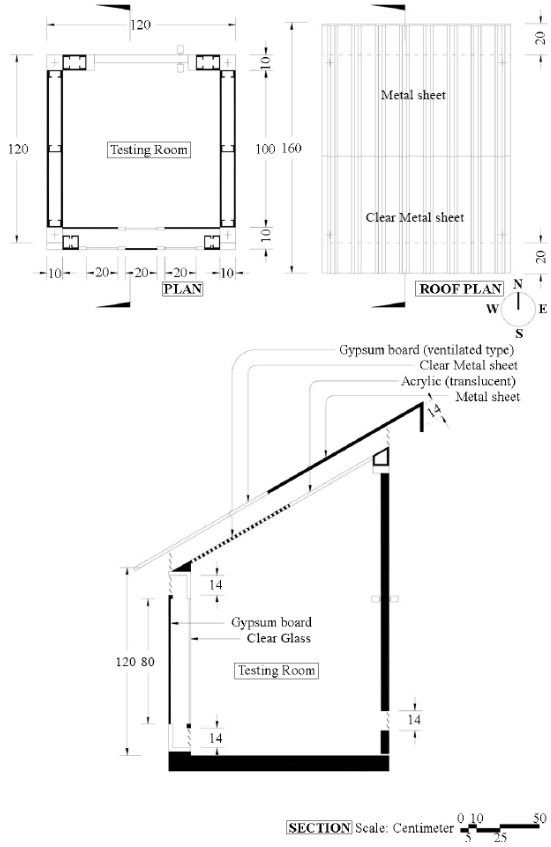

Figure 4. Show Model of the 3rd house model, Solar Chimney Wall with Daylighting (SC-WD), tested with Solar Chimney Metal Sheet Roof with Perforated Ceiling (SC-MSRPC)

The model house testing with Thermocouples (Type K) are installed for temperature testing in different locations at GW & MSR, TGGW & MSRPC and SC-WD & SC-MSRPC.

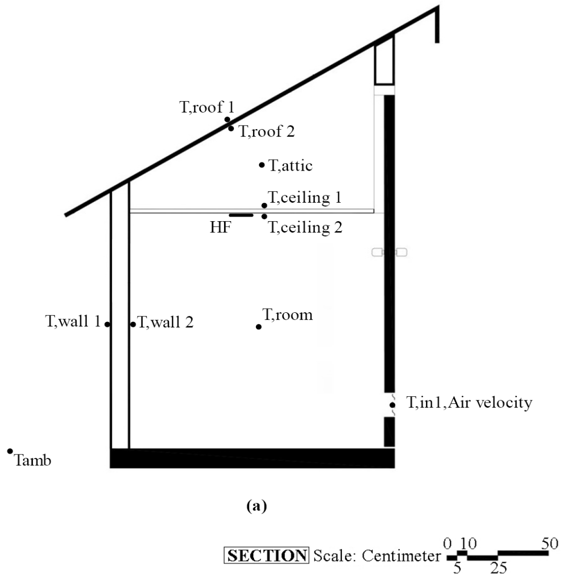

Figure 5. show the location of the measurement point of the model of the first house

Model of the first house, Gypsum Wall (GW) tested together with Metal Sheet Roof (MSR).

- T wall 1 = Outside GW
- T wall 2 = Inside GW
- T roof 1 = Outside MSR
- T roof 2 = Inside MSR
- T attic = Center of the attic
- T ceiling1 = On ceiling
- T ceiling2 = Under ceiling
- T room = Center of the room

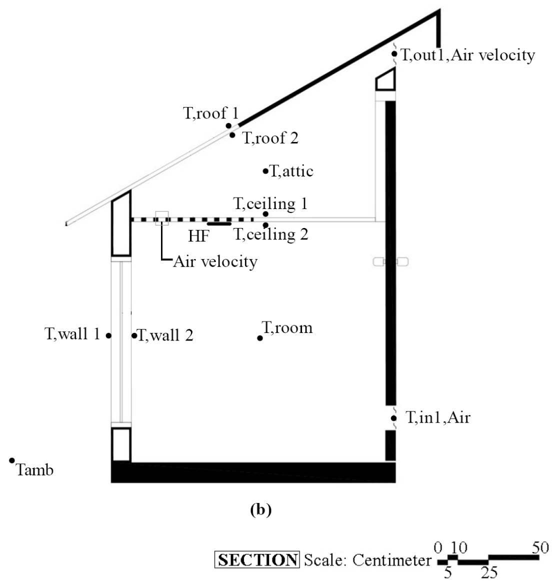

Figure 6. show the location of the measurement point of the model 2

Model 2 Tinted Glass with Gypsum Wall ; TGGW tested together with Metal Sheet Roof with Perforated Ceiling ; MSRPC

- T wall 1 = Outside TGGW
- T wall 2 = Inside TGGW
- T roof 1 = Outside MSRPC
- T roof 2 = Inside MSRPC
- T attic = Center of the attic
- T ceiling1 = On ceiling
- T ceiling2 = Under ceiling
- T room = Center of the room

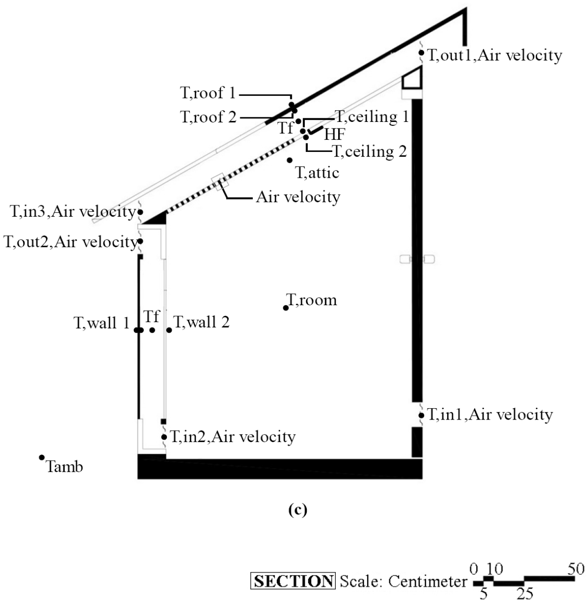

Figure 7. show the location of the measurement point of the model 3

Model 3 Solar Chimney Wall with Daylighting ; SC-WD tested together with Solar Chimney Metal Sheet Roof with Perforated Ceiling ; SC-MSRPC

- T wall 1 = Outside SC-WD
- T wall 2 = Inside SC-WD
- T roof 1 = Outside SC-MSRPC
- T roof 2 = Inside SC-MSRPC
- T attic = Center of the attic
- T ceiling1 = On ceiling
- T ceiling2 = Under ceiling
- T room = Center of the room

Experiments began from 6:00 a.m. to 6:00 p.m., with data recording every 30 minutes. Thai Model 3 Solar Chimney Wall with Daylighting Studies have not yet been found to be used in modern times.

Results

Wall temperature:

The temperatures at the different measurement locations of GW, TGGW and SC-WD are shown in Fig.8 - 11, respectively, which are caused by a continuous increase in heat transfer from solar thermal radiation through the wall.

Figure. 8 shows the temperature of the inner surface of the wall (Twall2) of GW is higher compared to (Twall2) TGGW and (Twall2) SC-WD, respectively, due to the solar vent wall causing air retardation. The temperature of the inner surface of the wall is therefore correspondingly lower.

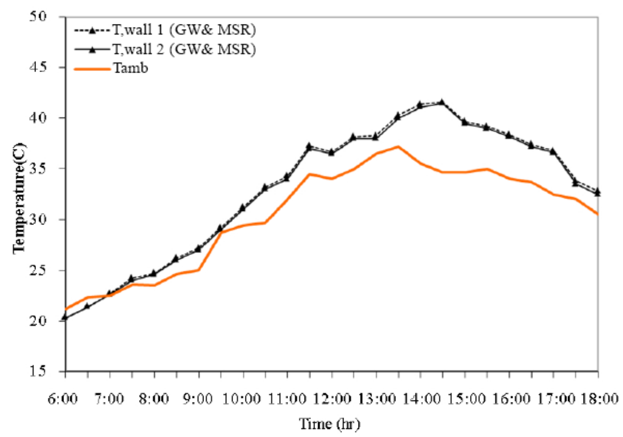

Figure 8. Show the different temperature variations of the walls GW

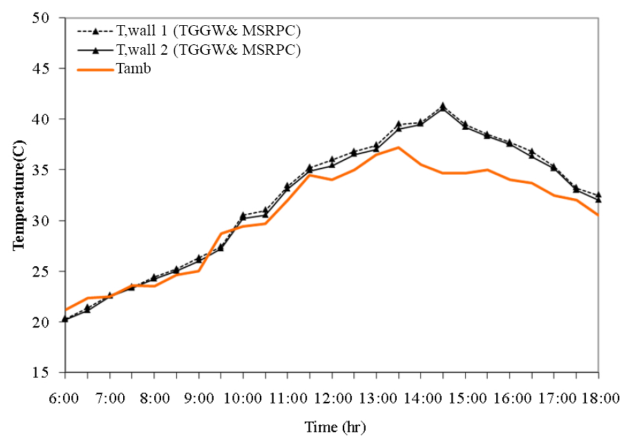

Figure 9. Show the different temperature variations of the walls TGGW

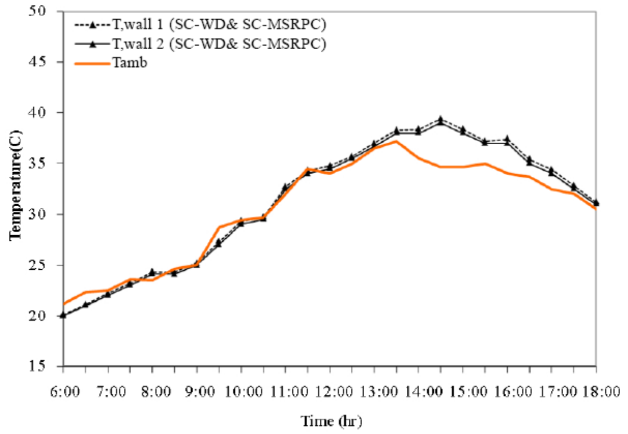

Figure 10. Show the different temperature variations of the walls SC-WD

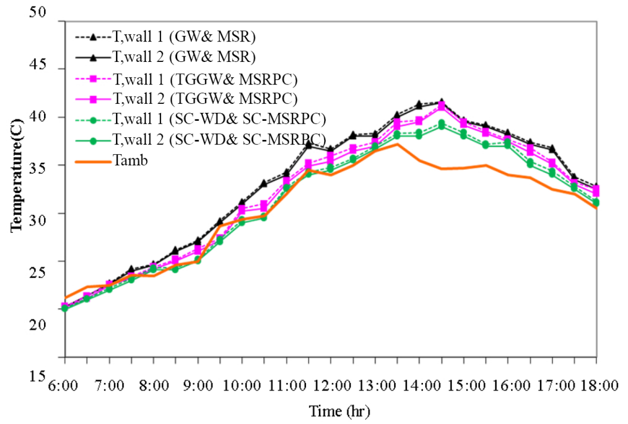

Figure 11. Show the different temperature variations of the walls GW , TGGW and SC-WD

Roof temperature:

The temperature at different measurement locations of the MSR, MSRPC and SC-MSRPC is due to the continually increased heat transfer from solar radiation through the roof. The fig.15 shows that the temperature of the inner surface of the roof (Troof 1) of MSR was higher compared to (Troof 2) MSRPC and (Troof3) SC-MSRPC, respectively, because the roof chimney caused air retardation. The temperature of the inner surface of the roof is therefore correspondingly lower.

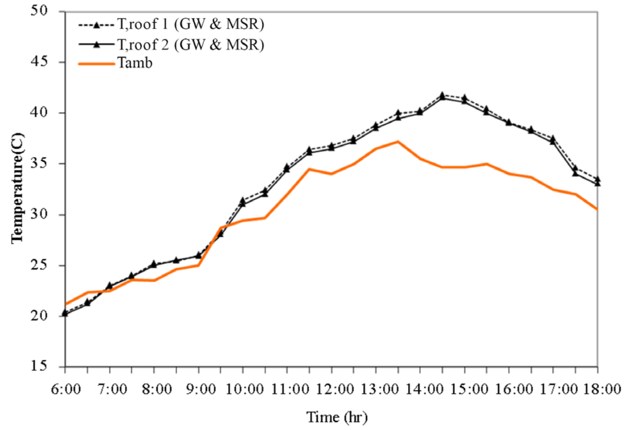

Figure 12. Show the different temperature variations of the roof MSR

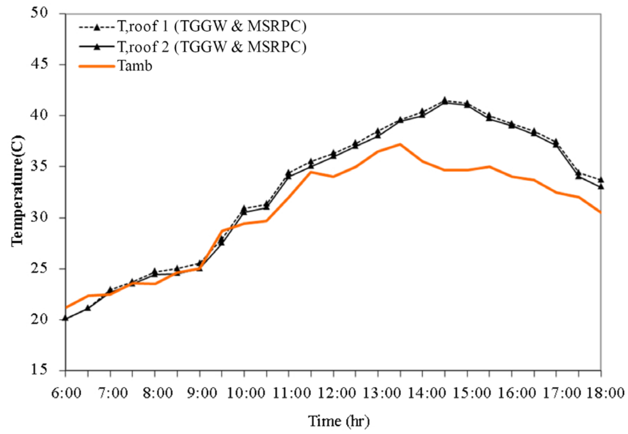

Figure 13. Show the different temperature variations of the roof MSRPC

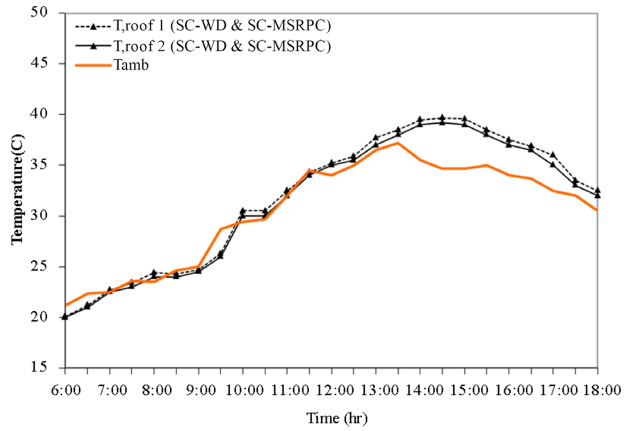

Figure 14. Show the different temperature variations of the roof SC-MSRPC

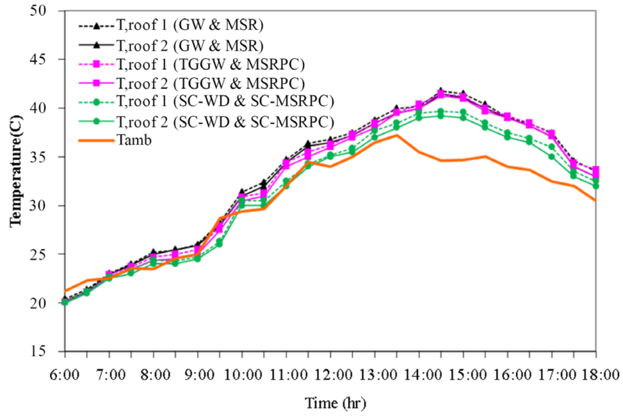

Figure 15. Show the different interior temperatures of MSR, MSRPC and SC-MSRPC

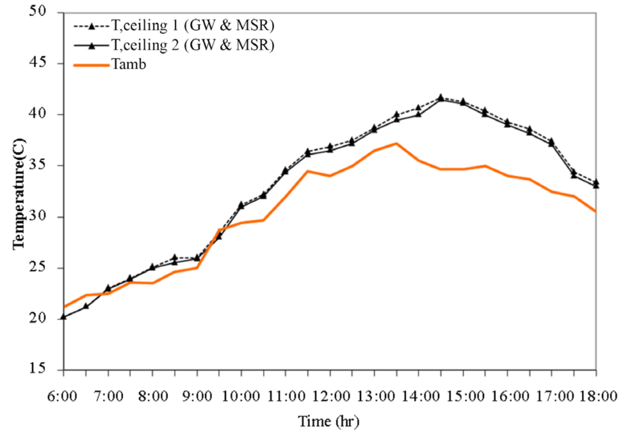

Figure 16. Show the different temperatures variations of the ceiling MSR

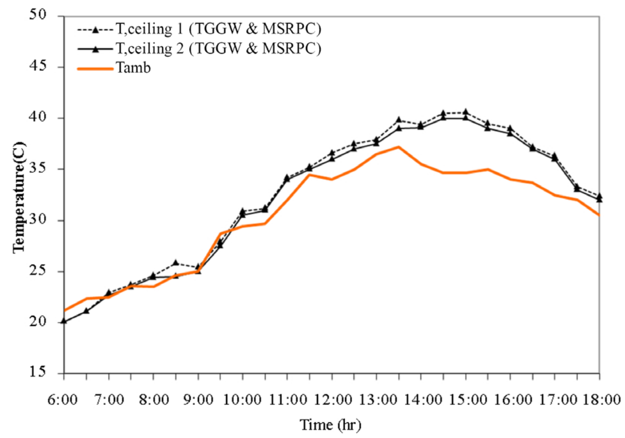

Figure 17. Show the different temperatures variations of the ceiling MSRPC

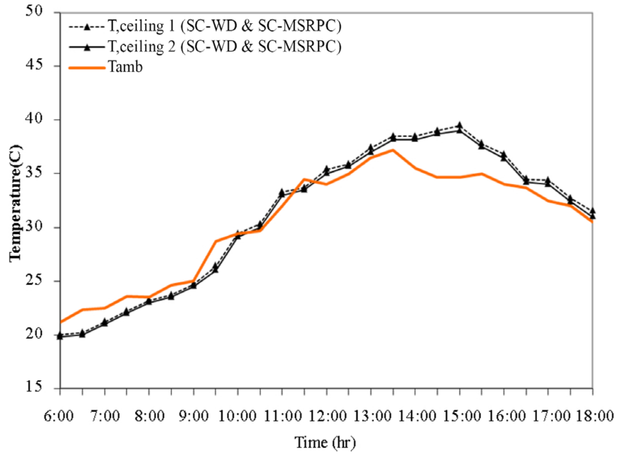

Figure 18. Show the different temperatures variations of the ceiling SC-MSRPC

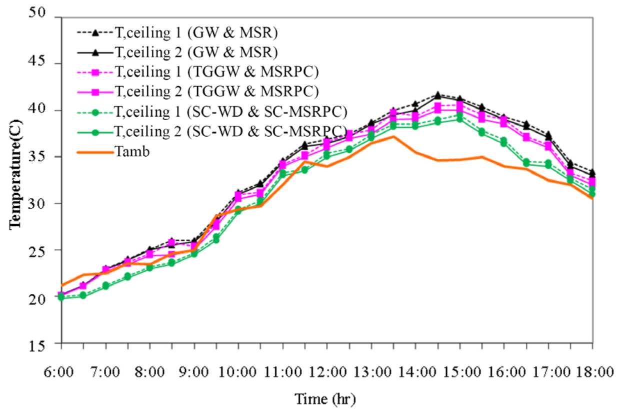

Figure 19. Show the different interior ceiling temperatures of MSR, MSRPC and SC-MSRPC

Attic temperature and test chamber temperature

Figure 20 shows the effect of the reduction of the heat flux through the wall. chimney wall solar radiation roof chimney roof solar radiation and attic The effect of heat radiation into the room is reduced. The attic and test chamber temperature of TGGW & MSRPC is lower than that of GW & MSR. It can be observed that the attic and test chamber temperature of TGGW & MSRPC is higher than that of SC-WD & SC-MSRPC. SC-WD & SC-MSRPC reduce near ambient temperature. as shown in Fig.21 and Fig.22

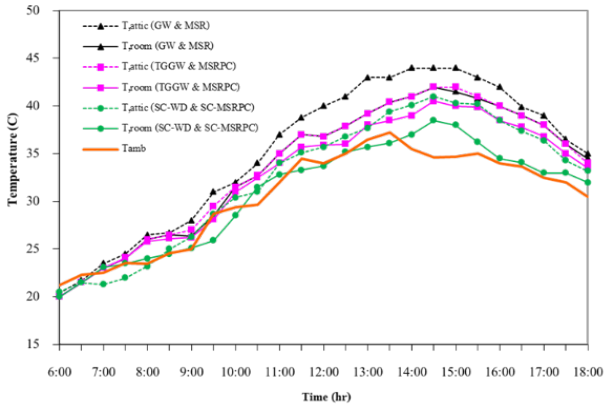

Figure 20. Show the Comparison of GW & MSR, TGGW & MSRPC and SC-WD & SC-MSRPC attic and test chamber temperatures.

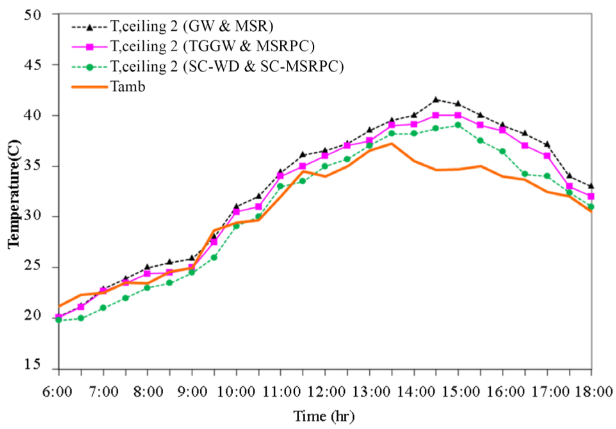

Figure 21. Show the Comparison of MSR, MSRPC and SC-MSRPC attic temperatures.

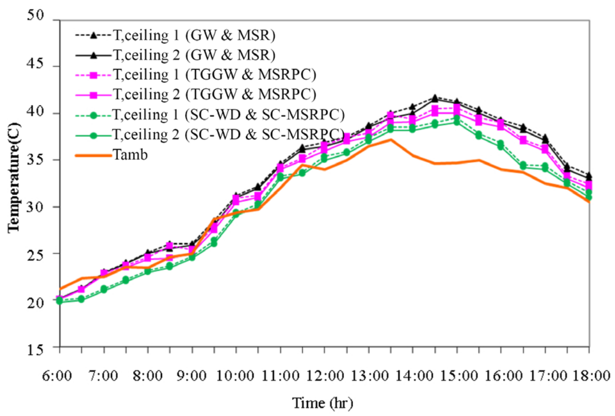

Figure 22. Show the comparison of MSR, MSRPC and SC-MSRP exam room temperatures

Conclusions

Energy-efficient house design based on natural ventilation. The third house that has installed a solar chimney wall to provide natural light, combined with a corrugated steel solar roof chimney and SC-WD & SC-MSRPC ventilation panels were designed in this research to be the most efficient. Compared to the 2nd house that has installed gypsum walls and tinted glass together with the rolled steel roof and ventilation ceiling TGGW & MSRPC and the 1st house that has installed the gypsum wall together with the roof. Rolled Steel GW & MSR .The 3rd house field tests showed that no overheating was observed at room temperature, it was often close to or below room temperature, which is of great interest to ventilation and airborne changes. Consistently quite high that varies between 2.8 and 8.5 watts per 1.44 sq m of surface area of the 3rd house SC-WD & SC-MSRPC. Observe that, during 12:00 - 18:00 the temperature difference between the attics space with room temperatures from ambient temperature of GW & MSR higher than TGGW & MSRPC and SC-WD & SC-MSRPC respectively due to the effect of attic space cannot ventilated. The average indoor illuminance of SC-WD & SC-MSRPC was higher than the standard illuminance by about 310 -910 lux. The air flow rate and number of air change by about 0.0025- 0.004 m^3/s (9-14 m^3/hr) and 2-8.5 ACH, respectively. The SC-WD & SC-MSRPC should be promoted for architectural and engineering designs.

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