Local Wisdom in Designing Vernacular Buddhist Holy Templesthat Creating the Thermal Comfort : Case study of Khun Kong temple's Sim in Nang Rong district, BuriRam province

Sombat Prajonsant [1*]
Visar Feangwiang [2]
Pipat Prajonsant [3]

Abstract

The objectives of this research project entitled "Local Wisdom in Designing Vernacular Buddhist Holy Temples (Sim) that Creating the Thermal Comfort: Case study of Khun Kong temple's Sim in Nang Rong district, BuriRam province" were to examine the architecture patterns, and to explain the body of knowledge of the local wisdom in designing the vernacular Sims for creating the thermal comfort to building occupants according to architecture disciplines and the results received from the scientific measurement.These Simaged over 400 years. The insides of the Simwas measured in terms of the air temperature, relative humidity, and air velocity (no MRT) by using scientific instruments since December 2012 to July 2013 in order to utilize the obtained data for explaining the architecture designing disciplines in creating the thermal comfort regarding the planning, roof shapes, building shapes, and designing the voids. The results from the study showed that throughout the day in winter, summer, and rainy season, the inside of Simsprovided the thermal comfort to the building occupants: the mean of temperature ranged between 23.40 °c - 35.90 °c, the mean of relative humidity ranged between 43.00 - 99.00%, and the mean of air velocity ranged between 0.07 - 0.55 meters per second. Even though the temperature was above the

[1*, 2, 3] *Lecturer, Faculty of Industrial TechnologyBuriRamRajabhat University BuriRam Thailand*

Bioclimatic Chart developed by Victor Olgyay, the temperature was in compliance with the field studies of Thai scholars-it was found that the thermal comfort has a high degree of correlation with local weather conditions, and the most important thing was the adaptability of the building occupants resulted in their comfortable feeling at all times. The results from the study helped explain the local wisdom in designing by using the architecture designing disciplines which provided the thermal comfort regarding building.

Keywords: Architecture, Vernacular Architecture, Thermal Comfort, Local Wisdom, Sim

Introduction

The vernacular architecture is rich of the stories depicting the history and wisdom of ancestors. This is similar to what ancestors of North Eastern people or Isan people in Thailand did. Isanancestors joined hands to build temples with their faith in each community since it was a belief from the old days that temples are houses for the Triple Gem, namely Buddha, teachings of Buddhism, and Buddhist monks. Therefore, the temples were built by placing the emphasis on permanent structures such as Sim (Isan Buddhist holy temples), pavilions, and monk chambers for housing the Triple Gem. So, the temples were used as Buddhist learning centers, the places for training and cultivating morals and ethics, the cultural resources in terms of morale/spirit as well as local arts and cultural resources because the craftsmen could show their craft skills in terms of fine arts, painting, sculpture, and architecture when building the temples. Thus, temples played an important role in being the centers of activities/religious rites and the spiritual centers of the communities from the past to the present. However, the current situation showed that many communities deconstructed the Simsthat their ancestors built rapidly. As Wirote Srisuro (2004: 9) noted that the cause of rapid destruction of Sims was that the abbots and temples' committees did not understand the value and uniqueness of Isanvernacular architecture. The differences between cultures (cultural diversity) were merged into one. It can be said that it was a symbol of absolute

power of the government that successfully gained control over the monks' committees in the region according to concepts and policies for centralization through a religious reform that passed along since reign of King Rama the 5th to the present (SomkidJiratatsanakul et al. 2007: 408) and this became the crisis of Isanvernacular Sims.

This research study was conducted to examine the local wisdom in designing the Simaged over 400 years, namely the Simat Khun Kong temple in Nang Rong district in Buri Ram province to indentify if the ancestors used the local wisdom that can be explained with the architecture designing disciplines to secure the thermal comfort to the building occupants rationally according to scientific disciplines, to be the database that will build the pride towards the identity of the communities which will result in the conservation of local Sims. Therefore, valuable architecture of the communities will not be disappeared and the roots of the important cultural heritage will remain in the local areas. This will lead the conservation in cultural heritage through the creation of an innovation in green architecture design to conserve the uniqueness of the vernacular architecture in the future.

Research objectives

1) To examine and survey architecture patterns of the case study (Sim).

2) To explain the body of knowledge of the local wisdom in designing the Sims for creating the thermal comfort to building occupants according to architecture disciplines and the results received from the scientific measurement.

Research methodology

This research was descriptive research. This research study was conducted with the case study (Sims), namely the Simat Khun Kong temple in Nang Rong district in BuriRam province. The research methodology consisted of 4 main steps as follows:

1) The information regarding the history of the buildings was collected from the building owners and examined. The buildings was surveyed and measured by employing measurement tools according to the vernacular architecture survey framework.

2) The 2D and 3D architecture designs were made by utilizing a computer program. These designs consisted of a floor plan, a roof plan, elevation, section, and perspective.

3) The heat radiation, air temperature, relative humidity, and air velocity of each building were measured 1 day a month for 8 months by employing scientific instruments such as thermometers, hygrometers, and anemometers. The collected data were used in plotting the bioclimatic chart in order to identify the thermal comfort times of each building in each month.

4) The architecture designing disciplines for creating thermal comfort were explained. The environmental factors such as planning, roof shapes, building shapes, and the voids were focused.

Conclusions

Khun Kong temple's Simin Nang Rong districtis local Buddhist Simsaged 400years respectively. TheSimwas constructed by using construction wisdom through the use of the local people and local constructors. The people builtthe Simwith their faith in Buddhism for the monks, so all of the monks can perform activities/religious rites that must be done together as stated in the Buddhist monks' disciplines (Vinaya) under the section "Sangkhakam" (deed performed by monks in the temple precincts) such as receiving robes (Kathin) and ordaining others. Each Simhas the main Buddha statue which represents the Buddha. This statue is the crucial spiritual center of each community from the past to the present. Khun Kong temple's Simis a single storey semi opaque vernacular Simlocated in "Prataksina" (clockwise) courtyard. ThisSimhas 5 rooms. The building structure was made of hardwood. The walls were constructed by using raw clay bricks. The bricks are slanting out of a lowest base. This base is called "Tan Kiang" (rectangular base with a raised plinth). The height of the walls does not reach the roof beam level leaving a space for ventilation around the building. Its roof is a double gable roof with front and back porch covered the roof and there are awnings

over the 4 sides of the building. As for the roof ornaments, there is no "Chofa" (gable apex), "Bairaga" (toothlike ridges on the sloping edges of a gable, representing the fin on the back of Naga), "Lamyong" (leave-like carvings along the edges of the roofs of Buddhist temple buildings), or "Haang Hong" (swan's tail/phoenix's tail decorative ornament). The building was decorated by using carving woods at the roof ridge and corners of gable ends.

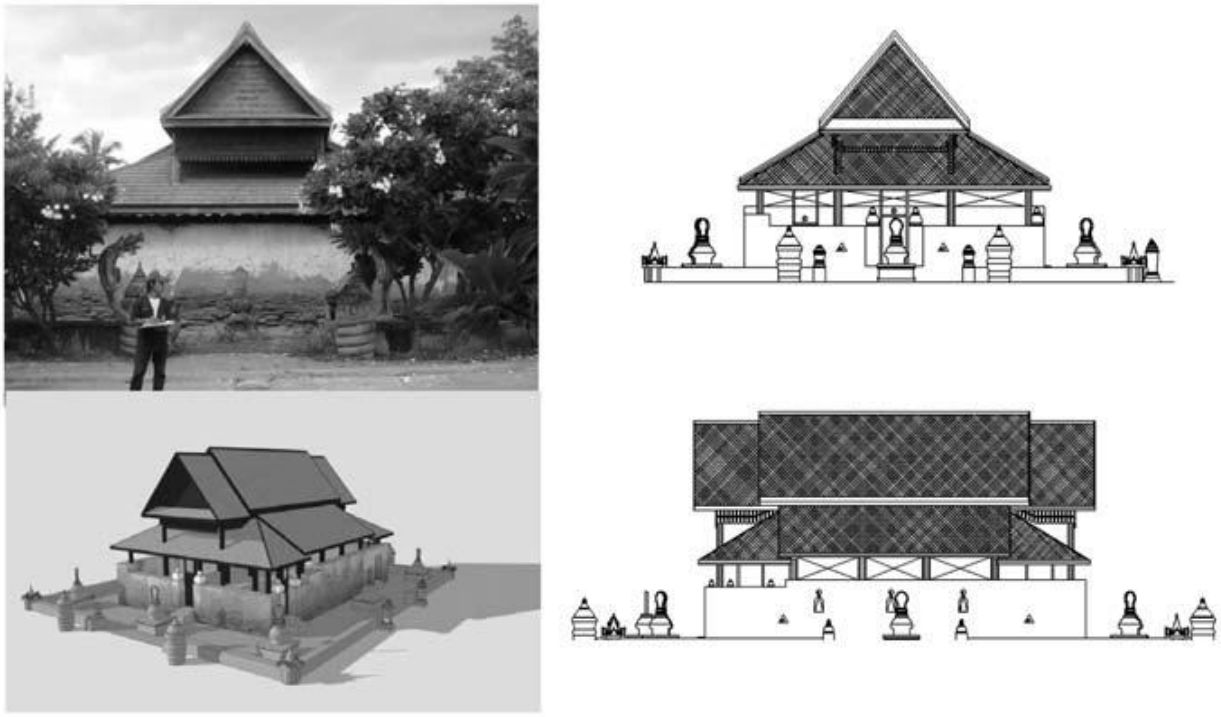


Figure 1 Khun Kong temple's Sim

Thailand is located between latitudes 5°37' North and 20°27' North. The thermal comfort criteria used as standards for comparing the results derived from the study consisted of:

1. Bioclimatic Chart developed by architect, Victor Olgyay (1963) It was noted that people will feel comfortable at the temperature between 22-27°c, relative humidity between 20-75%, underlow air velocity condition (about 0-1 kilometer per hour or 0-50 feet per second), and air temperature and mean temperature of the walls are equal.

2. Bioclimatic Chart of KitchaiJitkhajornwanichproposed a new thermal comfort zone which is different from the thermal comfort zone of Victor Olgyay.The results from Kitchai'sresearch entitled "Thermal Comfort and Adaptability to Living for Local People" showed that the suitable thermal comfort zone for the local people in the Western region of Thailand was Savana Climate. Kitchaiproposed the bioclimatic chart with thermal comfort zone at 25.6 - 31.5 °c with relative humidity at 62.2% (The range of acceptable temperature and relative humiditywas in the right range) (KitchaiJitkhajornwanich. 2007: 162). In this regard, the criteria of Victor Olgyay and KitchaiJitkhajornwanich were utilized in the current research study for comparison purpose because the criteriaarose from thermal comfort data collection in the field study in Thailand were different from data of the other researches that were collected inside labs. In summary, Thai people in the local areas are familiar with the dynamic local climate, so they adapted themselves or adjusted their environment to secure thermal comfort continuously in their ways of living. The acceptable feeling towards the climate of the Thai people in vernacular context were not inside the thermal comfort zone determined by Victor Olgyay. It can be said that the Thai people possessed the ability in accepting the thermal comfort at the temperature higher than thermal comfort zone determined by Victor Olgyay.

Figure 2 Surrounding of Khun Kong temple's Sim

In the current research, the air temperature, relative humidity, and air velocity of the three buildings were measured from December 2012 to July 2013 by using scientific instruments under the conditions as follows: opening doors and windows during daytime and nighttime and not turning on the ventilators. It can be concluded that during the eight months of the study, the temperature inside each building was different. The highest mean temperature was at 36.60 °c, the lowest mean temperature was at 19.10 °c, and the mean temperature was at 29.03 °c. When comparing the mean temperature inside and outside the Sims, it was found that the mean temperature inside the Sims was higher than the temperature outside of the Sims equaled 0.16 °c which was considered as having no difference or effect on the thermal comfort.

From table 1 from the comparison of mean temperature, relative humidity, and air velocity inside each building with the criteria of Victor Olgyayand KitchaiJitkhajornwanich, it was found that the mean temperatures inside the Sim was higher than the thermal comfort zone of Victor Olgyay but the relative humidity, air velocity inside the buildings were in thermal comfort zone of the aforementioned criteria. However, the mean temperature, relative humidity, and air velocity inside the Sim was in the thermal comfort zone of Kitchai Jitkhajornwanich.

Table 1 The comparison of mean temperature, relative humidity, and air velocity ofKhun Kong temple's Simwith the criteria.

item	Inside Khun Kong temple's Sim			Outside Khun Kong temple's Sim		
	Temperature (°c)	Relative Humidity (%)	Air Velocity(m./s)	Temperature (°c)	Relative Humidity(%)	Air Velocity(m./s)
Winter Mean	27.60	65.35	0.20	27.21	64.59	0.29
Summer Mean	30.68	75.49	0.21	30.46	74.83	0.29
Rainy Season Mean	29.89	74.69	0.18	29.56	73.85	0.27
Annual Mean	***29.33***	***71.48***	***0.20***	***29.02***	***70.90***	***0.28***
Victor Olgyay's Thermal Comfort (1973)	22-27	20-75	0 –1Km./Hr.	-	-	-
Results from Comparison	Mean temperature is higher than thermal comfort zone			-		
Thermal Comfort ofKitchai (2007)	25.60 – 31.5	62.20 - 90.00	0.10 -1.00 Km./Hr.	-	-	-
Results from Comparison	In thermal comfort zone			-		

When comparing with the thermal comfort zone of Kitchai Jitkhajornwanich by using the temperature and relative humidity recorded from the three buildings each day for 8 times as divided:

Winter: December, January, and February

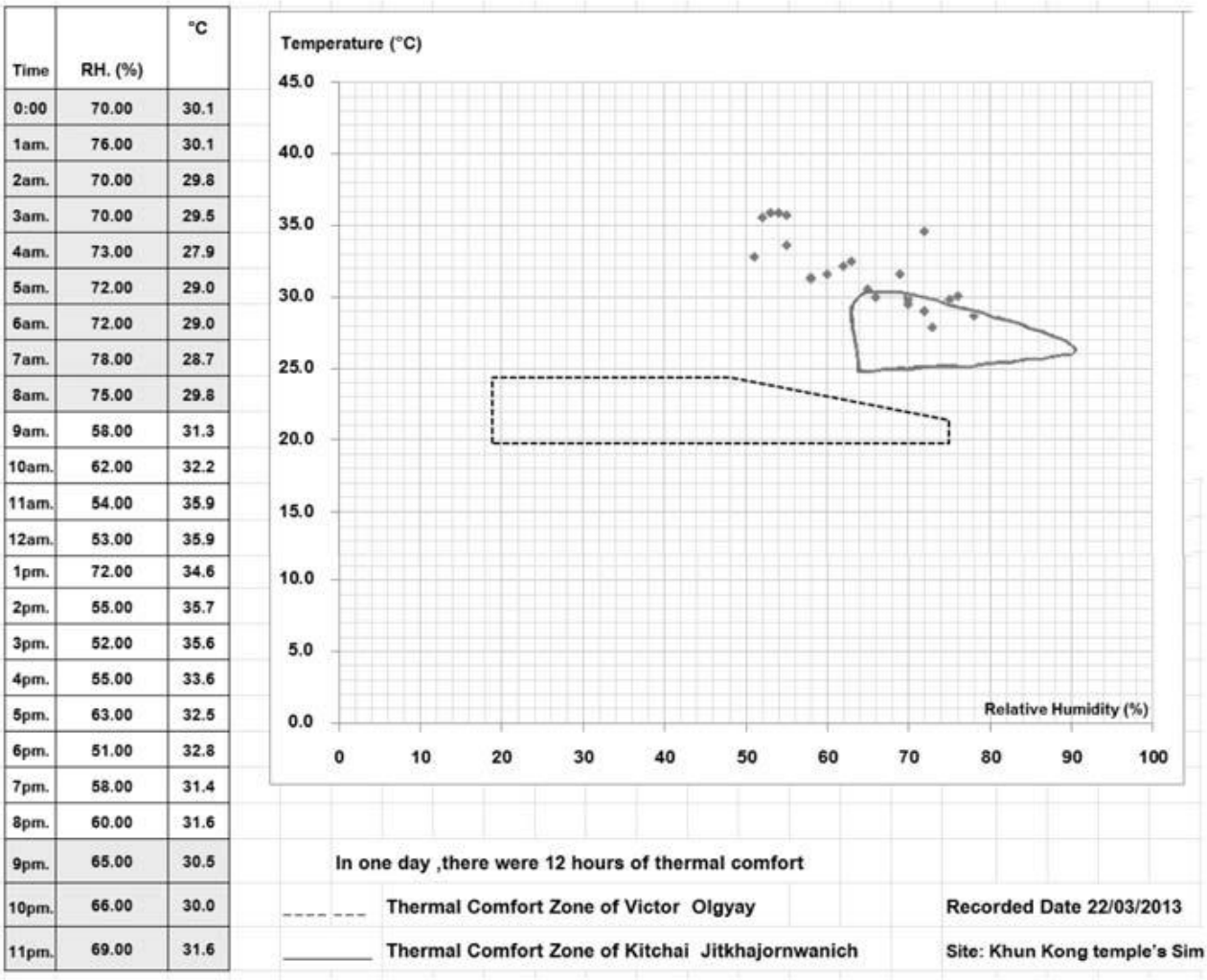
Summer: March, April, and May

Rainy season: June and July

It was found that Khun Kong temple's Sim was a building with high mass walls and there were 32% voids of the wall area. The highest mean temperature outside the Sim was 35.90 °c while the lowest mean temperature was 20 °c by having the mean temperature at 29.02 °c. The highest mean temperature inside the Sim was 35.90 °c while the lowest mean temperature was 23.40 °c by having the mean temperature at 29.53 °c. In winter, the building occupants were in thermal comfort about 10 times a day or 42%. In summer, the building

occupants were in thermal comfort about 10 times a day or 42%. And in rainy season, the building occupants were in thermal comfort about 14 times a day or 56%. In the whole year, there were 10-14 times of thermal comfort in a day on average.

In this regard, the examples of thermal comfort data of the three Sims can be presented. In the day with the hottest weather as in Figure 3, it can be seen that the mean temperatures inside the three Sims were higher than the thermal comfort zone of Victor Olgyay (dash line). However, some times were in thermal comfort zone of Kitchai Jitkhajornwanich (solid line). All year round, Khun Kong temple's Sim provided thermal comfort to the building occupants 88 times in 192 hours on average or 45.83%.



Time	RH. (%)	°C
0:00	70.00	30.1
1am.	76.00	30.1
2am.	70.00	29.8
3am.	70.00	29.5
4am.	73.00	27.9
5am.	72.00	29.0
6am.	72.00	29.0
7am.	78.00	28.7
8am.	75.00	29.8
9am.	58.00	31.3
10am.	62.00	32.2
11am.	54.00	35.9
12am.	53.00	35.9
1pm.	72.00	34.6
2pm.	55.00	35.7
3pm.	52.00	35.6
4pm.	55.00	33.6
5pm.	63.00	32.5
6pm.	51.00	32.8
7pm.	58.00	31.4
8pm.	60.00	31.6
9pm.	65.00	30.5
10pm.	66.00	30.0
11pm.	69.00	31.6

Figure 3 Thermal Comfort of Khun Kong temple's Simon 22 March 2013

From the aforementioned scientific data, it can be seen that wisdom of the ancestors in designing the Sims for creating the thermal comfort in terms of temperature to the building occupants can be explained with the architectural disciplines such as planning, roof shape, building shape, and opening design as follows:

Planning

1) Planning position of the building in the North-South direction by having the narrow side of the building facing East-West direction in order to reduce the building envelope that collecting heat in the East-West direction. (seeFigure 4)

2) Planting ground cover plants to increase the moisture, to reduce reflection of Sun rays on the ground that keeping the heat on the ground, to reduce heat intensity in the afternoon, and to reduce the temperature differences between inside and outside the building. (seeFigure 5)

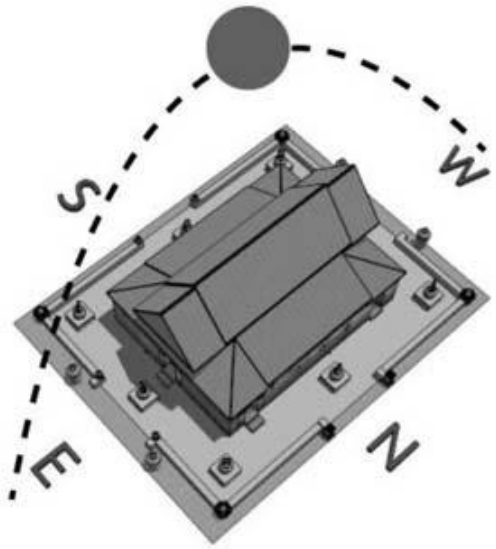


Figure 4 Planning position of the building

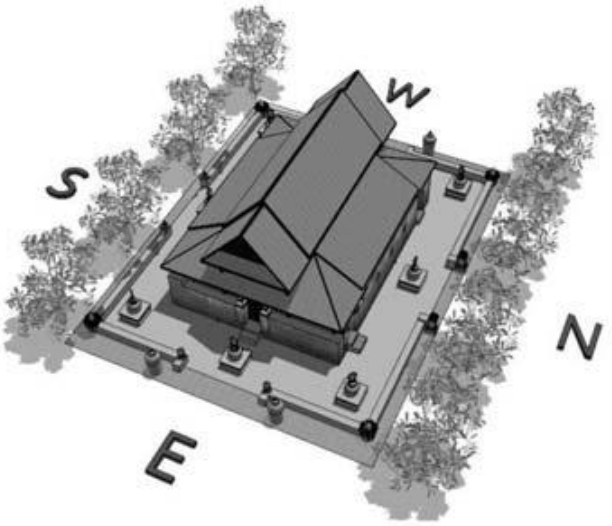


Figure 5 Planting ground cover plants

3) Utilizing big trees with sufficient leaves but not too thick for blocking the sunlight and providing shade to the building envelope. The big trees help filter out sunlight. Their roots absorb water from the soil, change water into water vapor, and help cooling the environment.

Roof Shape

1) Choosing roof shape to reduce sunlight receiving areas such as choosing gable roof instead of hipped roof because the sunlight receiving areas of gable roof are smaller than those of hipped roof.

2) Choosing high double layer roof helps to reduce the quantity of heat transfer effectively by using the space under the roof as a heat protection.

3) Having ventilators at the East and West pediments to help transfer heat out of the area under the roof. (seeFigure 6)

Figure 6 Having ventilatorsunder the roof

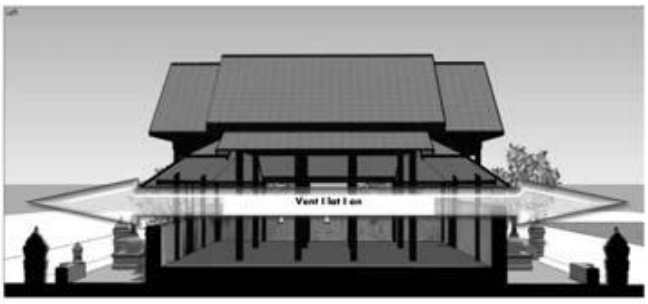


Figure 7 Open space inside the building

Building Shape

1) Khun Kong temple's Sim had the building ratio (width: length) of 1:1.4. The planning was made by planning the long side of the three Sims faced the North-South direction. The narrow side faced the East-West direction to reduce the building envelope that keeping the heat of the East-West direction.

2) The narrow and shallow shape building will have better ventilation system than the deep shape building. The better ventilation system created the air movement.

3) Choosing the building shape to have the open space inside the building as open hall for agood ventilation. (seeFigure 7)

4) Constructing the walls with bricks that were thick enough to reduce the heat transfer. The one layer brick walls had ratio of heat transfer lower than the thicker walls. The thicker walls possessed the heat delay period which protecting the heat to get into the building quickly. Early in the evening when the air outside becomes cooler, the heat keeping inside the walls and roof will transfer into the building at that time.

5) Increasing the cooling surface area by covering the floor with earthenware tiles or ceramic tiles to draw the coolness from the ground into inside of the Sims.

Voids

1) Having the voids in the North-South direction to make it easy for blocking the sunlight and providing shade to the building because this direction receives the wind all year round which will help blow the humidity away.

2) Determined the direction of the inlet voids on the walls and the outlet voids on the opposite walls to create the cross ventilation where air enters on one side of the building and leaves on the opposite side.

3) The positions and sizes of inlet and outlet ventilation areas are equal, so the maximum quantity of the wind can come inside the room resulted in air movement inside the building.

4) The void area of Khun Kong temple's Sim was 32% of wall area.

5) Constructing the East-West walls as the opaque walls because it was difficult to construct sunshades in these two directions to block the low angle sunlight when sun came down, so the heat was kept inside the building.

Throughout the day in winter, summer, and rainy season, the inside of the Sim provided the thermal comfort to the building occupants: the mean of temperature ranged between 20 °c - 35.90 °c, the mean of relative humidity ranged between 44 - 99%, and the mean of air velocity ranged between 0.11 - 2.18 meters per second. Even though the temperature was higher than the temperature in the Bioclimatic Chart developed by Victor Olgyay but it corresponded with the findings of KitchaiJitkhajornwanich's field study that the thermal comfort has a high degree of correlation with local weather conditions, and the most important thing was the adaptability of the building occupants resulted in their comfortable feeling at all times.

Discussion

When using the temperature and relative humidity recorded from the three buildings each day for plotting in the bioclimatic chart, it was found that the mean temperatures inside of the Sim was higher than the thermal comfort zone of Victor Olgyay (1963) which corresponded with Kitchai Jitkhajornwanich (2007 : 161) who concluded that there were many researches indicated that the thermal comfort of the people in the tropical region usually have higher temperature and relative humidity than determined standards. The main reason for this was that the thermal comfort has a high degree of correlation with local weather conditions, and the most important thing was the adaptability of the building occupants resulted in their comfortable feeling at all times. It was also found that Khun Kong temple's Sim was a building with high mass walls and there were 32% voids of the wall area. The temperatures inside the Sim washigher than temperature outside. This finding was corresponding to and different from the research results of Sunsuda Jiemjit (2005 : 110,166) who indicated that the temperature inside the medium mass building (with one layer plastered brick walls) was higher than the temperature outside the building. The temperature inside the low mass building (with wooden walls) was changed dramatically throughout the day depending on the climate outside the building. The temperature inside high mass building (with two layer plastered brick walls) was relatively stable almost all day. The temperature inside the building was lower than the temperature outside the building during day time and the temperature inside the building was higher than the temperature outside the building in the night time under the condition of having 30% of voids. This may happen because the quantity of the voids at the Sim was different from the condition. Therefore, local wisdom in designing vernacular architecture (Sim) can be explained according to the tropical region architecture disciplines in terms of planning to construct the building in the North-South direction, planning the narrow side of the building facing East-West direction, planting big trees and ground cover plants, choosing the roof shape that reduces the sunlight receiving area, using high roof with the good ventilation under the roof,

choosing the building shape to have narrow and shallow shape leaving the open space inside the building as open hall for ventilation, choosing the energy saving materials for floors, walls, and ceilings, constructing the East-West walls as the opaque walls, and designing the voids in the North-South direction by planning the positions and inlet and outlet ventilation areas of equal size to be placed opposite to each other which corresponded with Chanin Thipyophas (2000: 4-33), Wichain Suwannarat (1994: 63-87), Trungjai Buranasomphop (1996: 47), Phanchalath Suriyothinet al. (1998 : 127-131), and Soontorn Boonyatikarn (1999 : 204-207).

Suggestions

1) Apart from the historical information, the results received from the explanation on the local wisdom in terms of designing Sims for providing the thermal comfort may be one of the important information for explaining the value of vernacular architecture. And the information should be publicized to the communities and the public. So, the people will realize the value of vernacular cultural heritage and value the community identity and be proud of it and consequently, conserve the vernacular architecture to be the cultural heritage in the future.

2) Educational institutes should develop local curriculum regarding vernacular architecture in order to build knowledge and understanding to children and the youth in the local communities. So, they will be aware of the value of local identity and will not look down on the beauty of the works created by local craftsmen.

3) Local Administrative Organizations (LAOs) which are government agencies at the community level must be well aware of the roles and responsibilities of their organizations as well as the community participation as stated in Section 46 of Constitution of the Kingdom of Thailand 1997. Then the LAOs should work together with Local Fine Arts and Environment Conservation Agencies that are available across the country.

4) Inform the study to the other Sims or other vernacular architecture in the future.

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