

# Analysis Thermal Comfort Condition in Complex Residential Building, Case Study: Chiangmai, Thailand

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**Abstract.** Due to the increasing need for complex residential buildings, it appears that people migrate into the high-density urban areas because the infrastructural facilities can be easily found in the modern metropolitan areas. Such rapid growth of urbanization creates congested residential buildings obstructing solar radiation and wind flow, whereas most urban residents spend 80-90% of their time indoor. Furthermore, the buildings were mostly built with average materials and construction detail. This causes high humidity condition for tenants that could promote mould growth. This study aims to analyse thermal comfort condition in complex residential building, Thailand for finding the passive solution to improve indoor air quality and respond to local conditions. The research methodology will be in two folds: 1) surveying on case study 2) analysis for finding the passive solution of reducing humidity indoor air. The result of the survey indicated that the building need to find passive solution for solving humidity problem, that can be divided into two ways which raising ventilation and indoor temperature including increasing wind-flow ventilation and adjusting thermal temperature, for example; improving building design and stack driven ventilation. For raising indoor temperature or increasing mean radiant temperature, daylight can be passive solution for complex residential design for reducing humidity and enhance illumination indoor space simultaneous.

## 1. Introduction

Thailand is characterized by high rainfall and high humidity and the temperature range is relatively high around 30 - 35°C throughout the year [1]. With these geographical features of Thailand, architectures are designed and planned to be compatible with the climate and life style of Thai people in different regions; houses and buildings are varied and distinctive throughout the country [2]. Nonetheless, the growth of globalization and capitalism, a great number of people migrate into metropolis; many areas in Thailand, for example, are crowded and overpopulated [3, 4]. Complex residential buildings are built in minimized land to house a number of people in these particular cities. In addition, the survey of the Thailand Community Organization Development Institute addressed urbanization in Thailand has also conduct to urban poverty, which had some 6,300 urban poor communities with 1.6 million low-socioeconomic families and 30% of these located in big cities [5]. In such areas, those buildings are merely planned according to the environmental and geographical



matters and are built with negligible infrastructure; this, consequently, leads to unsuitable residents of the tenants [6].

Although the urban regulations were issued to relieve the buildings' environment in Thailand such as building coverage ratio, open space ratio, and setback regulation, there remains an ineffective thermal comfort standard of the indoor as obviously be seen mould on furniture surface in the rooms [7]. Mould is one of the indicator of indoor air problems in the buildings [8]. Furthermore, the buildings in those rapid urban increment are faced with a serious effect of solar radiation and wind flow obstructed problems [9, 10] and extremely impacts on the buildings with informal planning, such as, small opening areas, maximum land used and average construction details [11]. Such Thailand government solution does not take advantage to tenants to obtain optimal comfortable condition because the low-socioeconomic people cannot incorporate mechanical cooling devices to deal with exceedingly climates condition [12].

This scope of this study is to analyse thermal comfort condition in complex residential building, Thailand for finding the passive solution to improve indoor air quality and respond to local conditions.

## 2. Literature Review

### 2.1 Thai's thermal comfort condition

Chiangmai, Thailand is located in Southeast Asia, latitudes  $18.79^{\circ}$  N and longitudes  $98.98^{\circ}$  E, it is also tropical climate. According to the studies, the recommended thermal comfort level of temperature and indoor humidity is in the range of  $21\text{--}30^{\circ}\text{C}$  and  $20\text{--}80\%\text{RH}$  respectively [13]. The recent study reviews that the perception of thermal comfort level of people who live in hot-humid region is increasing depending on their environment [14]. The range of thermal comfort is not fixed. It depends on the differences of people and climate factors as shown in many ecological and climate data collecting that demonstrate varied temperature results [15]. Nittaya reviews Thai' thermal comfort condition is in the range of  $21.9\text{--}29.4^{\circ}\text{C}$  and  $20\text{--}50\%\text{RH}$  [16]. Karnchanawiroj asserts that Thai' thermal comfort condition is in the range of  $25.6\text{--}31.5^{\circ}\text{C}$  and  $37.7\text{--}62.9\%\text{RH}$  [17]. Therefore, this study determines that comfort condition is in the range of  $21\text{--}30^{\circ}\text{C}$  and  $20\text{--}80\%\text{RH}$  (figure 1); because these bands cover all range in aforementioned; which will be used to clarify in next step.

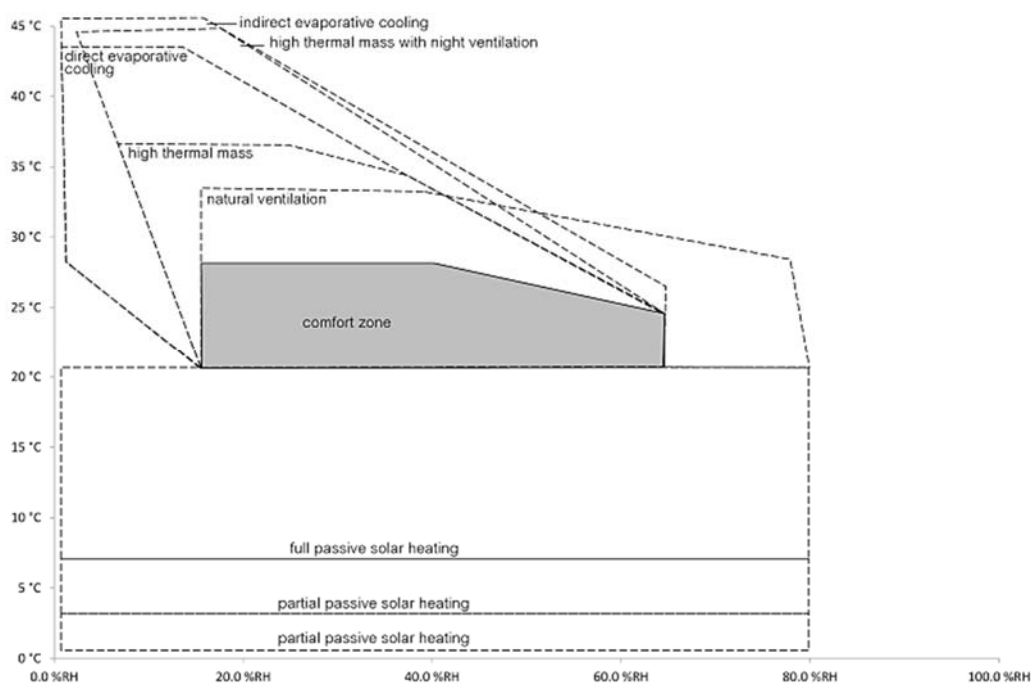


Figure 1. Bio climatic chart (Source: Olgyay, V.1963)

## 2.2 Field study of complex residential building

In the field survey in complex residential building, Chiangmai, Thailand, the building was built with maximized land use and constructed with the width, length, and height 35.6 meter, 53.2 meter and 22 meter respectively. Furthermore, the width, length, and height of the neighbourhood residential building is 26.6 meter, 41.4 meter and 18.8 meter respectively (figure 2). Most windows were disguised because the tenants may need privacy view from neighbourhood residents by disguising their windows that bring about inadequate indoor daylight, room design with few opened even limits the ventilation.



Figure 2 a) the perspective of case study building, b) room planning of the case study

## 3. Research Method

### 3.1 Research objectives.

To analyse thermal comfort condition in complex residential building, Thailand for finding the passive solution to improve indoor air quality and respond to local conditions.

### 3.2 Research processing steps

- 1) Studying and gathering related information, method, and basic theories
- 2) Exploring the case study building of the building, such as, form, exterior construction details, room planning, materials and the influence from neighbourhood residential building
- 3) Collecting data
  - 1) Determine variables
    - 1) Independent variable; the area of gathering data such as, exterior and interior
    - 2) Dependent variable; temperature and relative humidity value of the indoor air
    - 3) Controlled variable; complex residential building with is 28 square meter room area which opening only on one side with a width of two meter, gathering data in 6 months: July, August, September, October, November, December
- 4) Analysing information
  - 1) Comparing relative humidity and temperature value between indoor and exterior air
  - 2) Finding the relationship between relative humidity and temperature value
  - 3) Analysing thermal comfort condition

### 3.3 Research scope

This research is a comparative research on temperature and relative humidity value of the indoor and exterior air of complex residential building in urban area, Chiangmai, Thailand, (latitudes 18.79° N and longitudes 98.98° E)

#### 4. Results and discussion

From collected data of outdoor and indoor temperature and humidity level in complex residential buildings area; it shows that the temperature and humidity level outside the apartment are inverse relation. However, the result in indoor area is that the temperature is too stabile. Meanwhile, the indoor humidity level is fixed at 80% RH that exceeds the comfort condition (Fig. 3). Moreover, mould can be found in these places.

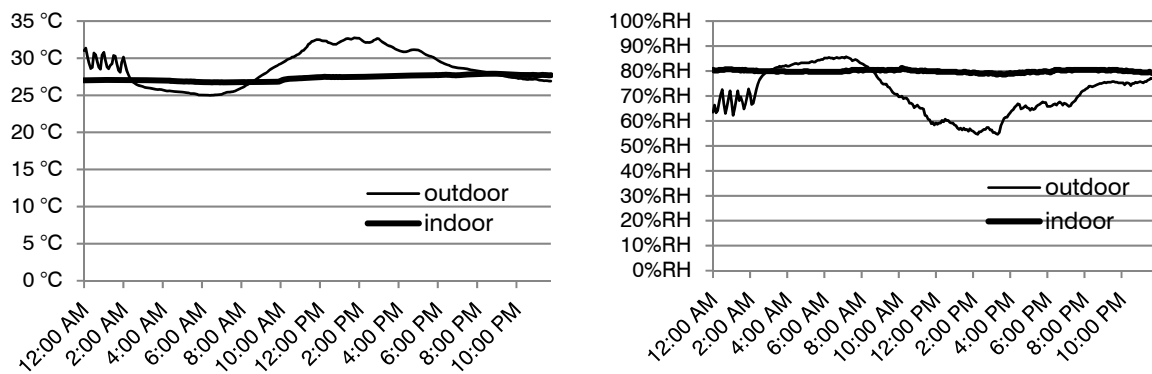


Figure 3 temperature and humidity level of outdoor and indoor complex residential buildings

The relationships of temperature and relative humidity values of outdoor air vary between the comfort zone with natural ventilation and outer (figure 3 (a)) that obviously alter to the result of indoor air. In term of the relationships of temperature and relative humidity values of indoor air cluster in one point and out of comfort zone (figure 3 (b)) that influence indoor discomfort to tenants with high humidity. This suggests that the complex apartment's rooms are need to find the passive solution to decrease humidity because it is the design to can improve the building user's comfort and health while minimize energy use and respond to local conditions.

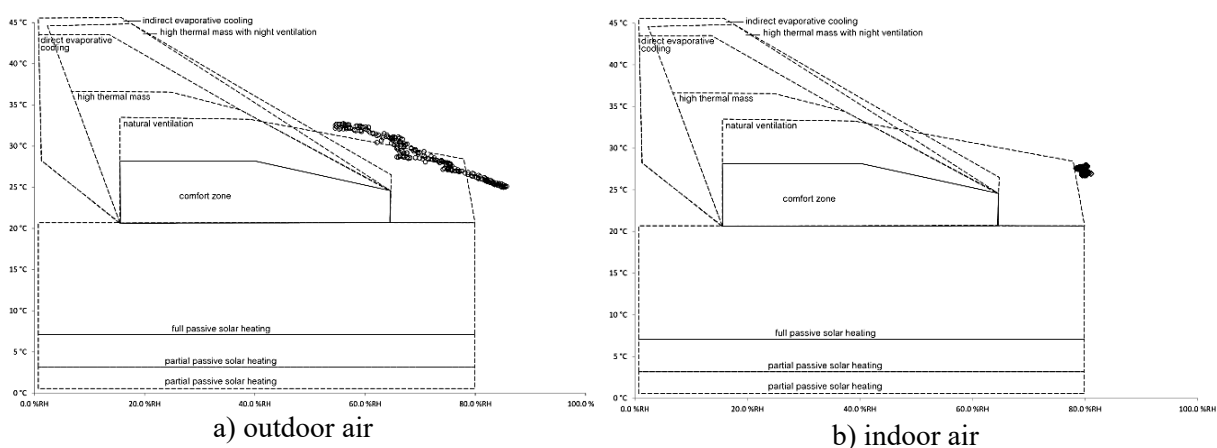


Figure 4 the relationship between temperature and humidity level in thermal comfort chart

According to the psychrometric chart, internal humidity can be controlled by raising ventilation or indoor temperature [18]. There are variable passive solutions, including increasing wind-flow ventilation and adjusting thermal temperature. Raising ventilation solution in order to decrease humidity is more practical and also eliminates heat from indoor spaces in term of the building that have efficiency wind flow. There are various methods to employ wind flow for example; firstly, improving building design such as types, shape and size of openings, window typologies and operations, building form and another is stack driven ventilation. For raising indoor temperature or

increasing mean radiant temperature, daylight can be passive solution for complex residential design for reducing humidity and enhance illumination indoor space simultaneous.

## 5. Conclusions

The results of field study indicated that the room in complex residential building need to find the solution to decrease humidity indoor air. The passive solution for solving humidity problem can be divided into two ways which raising ventilation and indoor temperature.

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