



# A Study of Environmental Factors in the Adaptive Re-use of a Historic Building in Hong Kong

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## 1. Introduction

King Yin Lei is a three-storey-mansion with a subsidiary single-storey structure located at Mid-Levels on Hong Kong Island. It was built by a Guangdong merchant in 1937 as a family residence. The government is recently considering to conserve the place for adaptive re-use. Thus, the feasibility of preserving the building fabric and fittings without the installation of an air-conditioning system is studied by carrying out a one year monitoring programme to understand the environmental condition of the building.



(1) Interior of King Yin Lei

### Significance

Reflects the design and construction excellence in Hong Kong's architecture in the 1940s

Symbolizes the rise of the Chinese merchant class before the Second World War

Represents an earlier phase of Hong Kong history when the upper-class residential area took shape in the Mid-levels



(2) Front elevation of King Yin Lei

### Architectural Features

#### Chinese Renaissance Style

- Rich in Chinese architectural features
- Influence of Western architecture in the structure and material used

#### Material

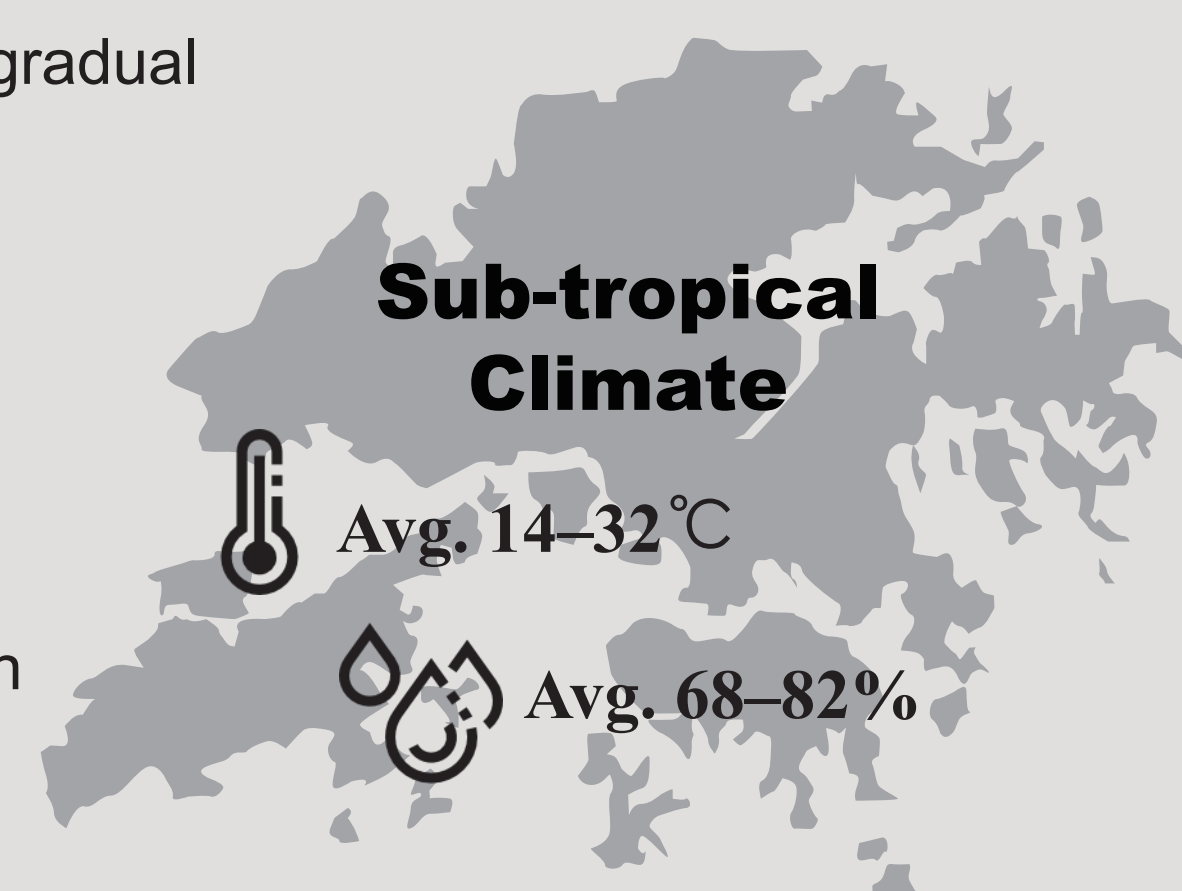
- Reinforced Concrete structure
- Red, fair-faced polished brick wall
- Granite dados on the ground floor
- Plastered inner walls
- Green-glazed roof tiles

### Hong Kong Climate

Four distinct seasons with gradual and mild transition

Hot and humid spring and summer

Temperate and cool autumn and winter

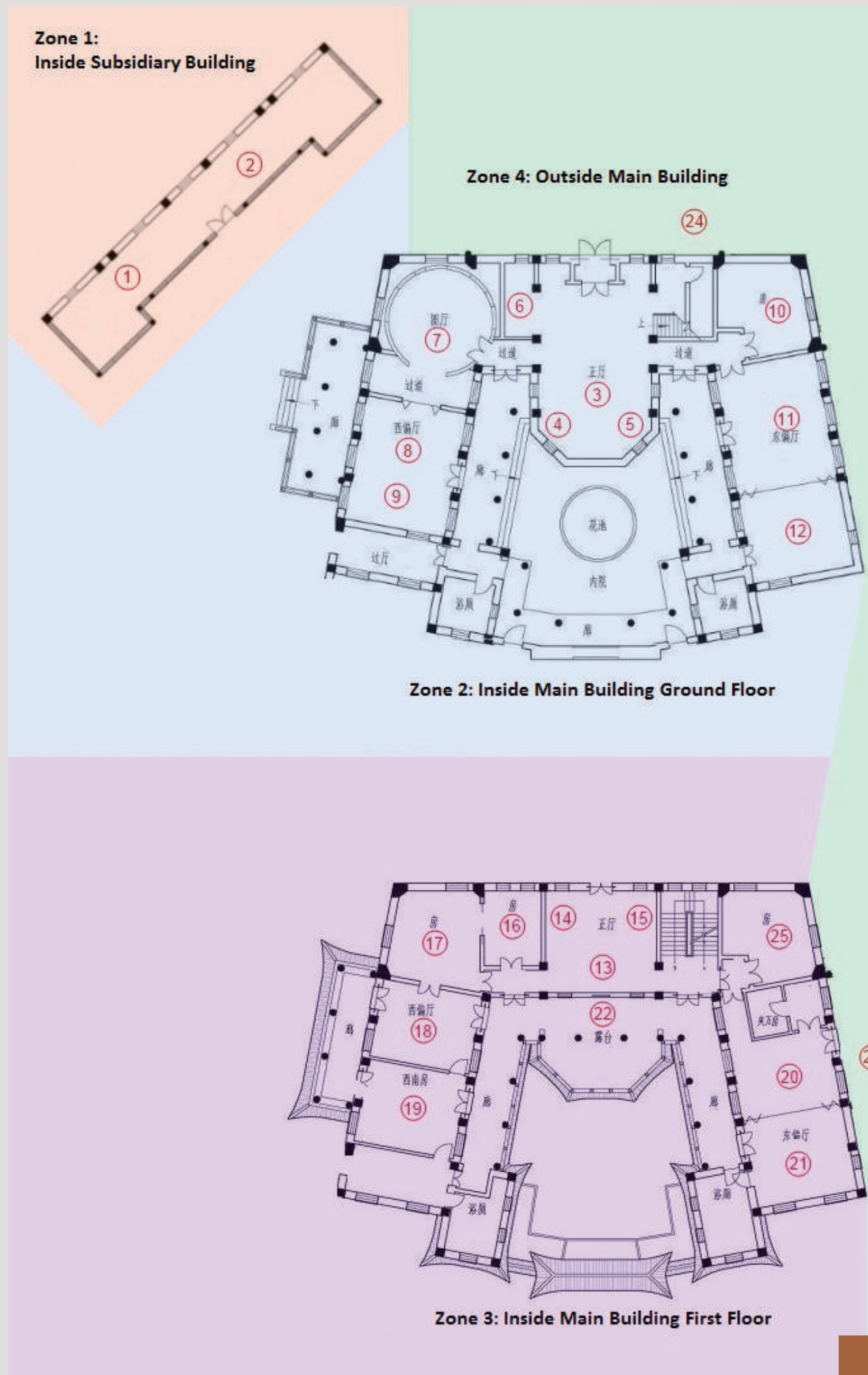


Most likely to be affected by tropical cyclones (Typhoons) during July to September

Occasional cold fronts in January and February with a sudden drop in temperature of > 5°C and in relative humidity (RH) of >20% within 24 hours

## 2. Methodology

The one-year environmental monitoring programme was carried out from July 2015 to July 2016. 25 data loggers were placed in different locations inside and outside the building. The range of RH and temperature as well as daily and seasonal fluctuations in various rooms on different floors with windows and doors opened or closed had been recorded.



(3) Location of the twenty-five data loggers in King Yin Lei

### Recording Relative Humidity and Temperature

Zone	Location of Sensors	Function
1-3	Center of the room, 1.2 m above the floor	Measure environmental conditions inside the building
4	Balcony of the building, 1.2 m above the floor	Measure external environment

### Investigating Impact of Air Circulation Through Windows and Doors on The Internal Environment

- Doors and windows on all floors of King Yin Lei were opened in the daytime from 9 a.m. to 5 p.m. every other week.
- The absolute humidity (AH) inside and outside the building were compared to assess how air circulation affected the internal environmental conditions of the building.

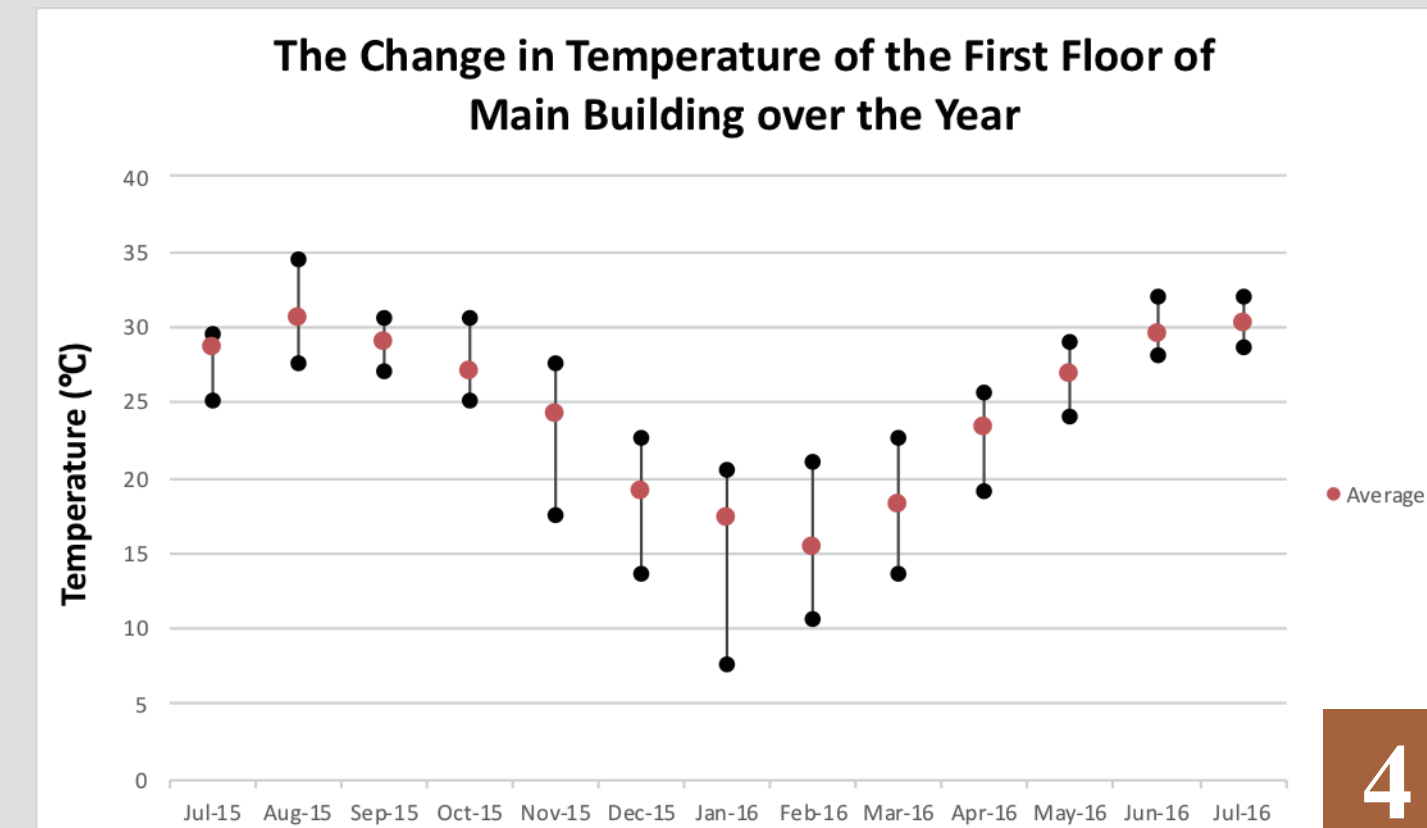
## 5. Conclusion

The environmental study shows that it is acceptable not to install an air-conditioning system in King Yin Lei for its preservation and the display of artefacts. Such a strategy and approach will not only impose the least alteration to the fabric of the historic building, but also helps to minimise the carbon

## 3. Findings and Analysis of Data

### General Observations

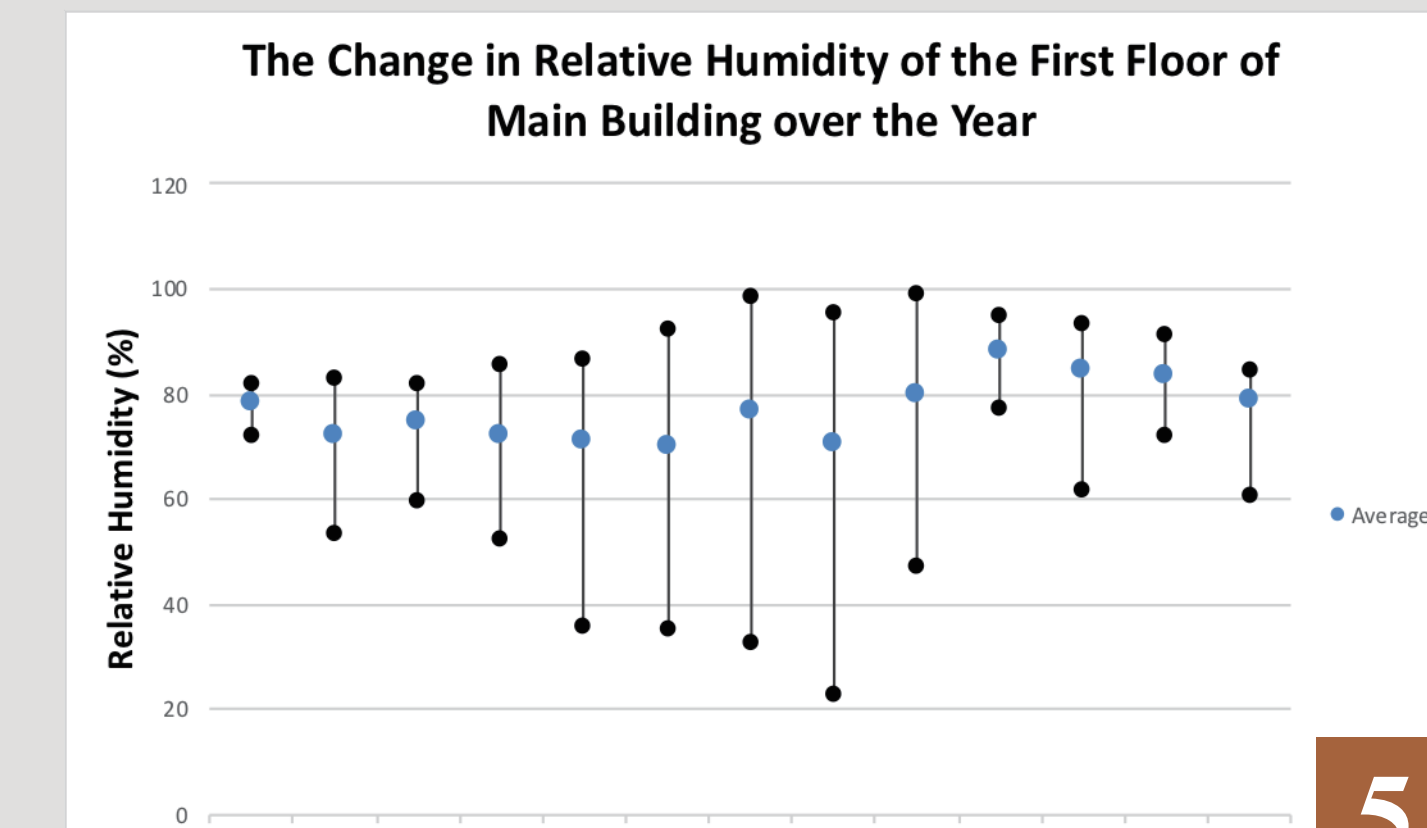
- Temperature and RH in King Yin Lei changed gradually between the seasons and daily fluctuation was mild (Figure 4 and 5).
- Daily temperature and RH fluctuations were often within the range of  $\pm 1^\circ\text{C}$  and  $\pm 6\%$  respectively.
- No sign of rising damp or water infiltration on the building's wall surfaces.
- Other moisture inputs into the building is low.



(4) The change in temperature of 1/F, main building over the year (from sensor 13). Similar changing patterns are found at other locations.

### Buffering Capacity of Building Fabric Against External Environment

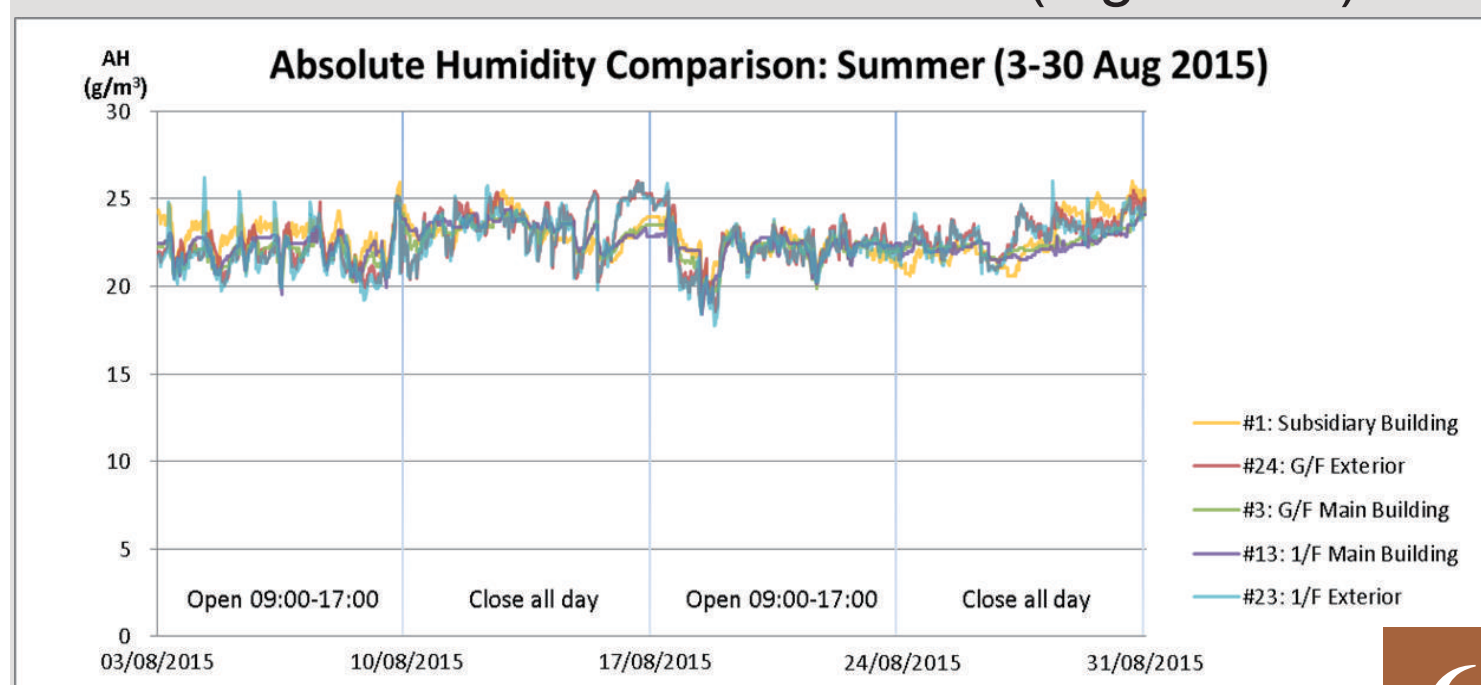
- AH, RH and temperature inside the subsidiary building and the main building were observed to be less fluctuating than the exterior in all seasons, no matter the room doors and windows were opened or closed (Figure 6-9).
- The building fabric is able to provide a primary buffer to the interior of the building against the fluctuating external environmental condition.
- Buffering capacity of the building fabric: (from highest to lowest) 1/F Main building > G/F Main building > Subsidiary building



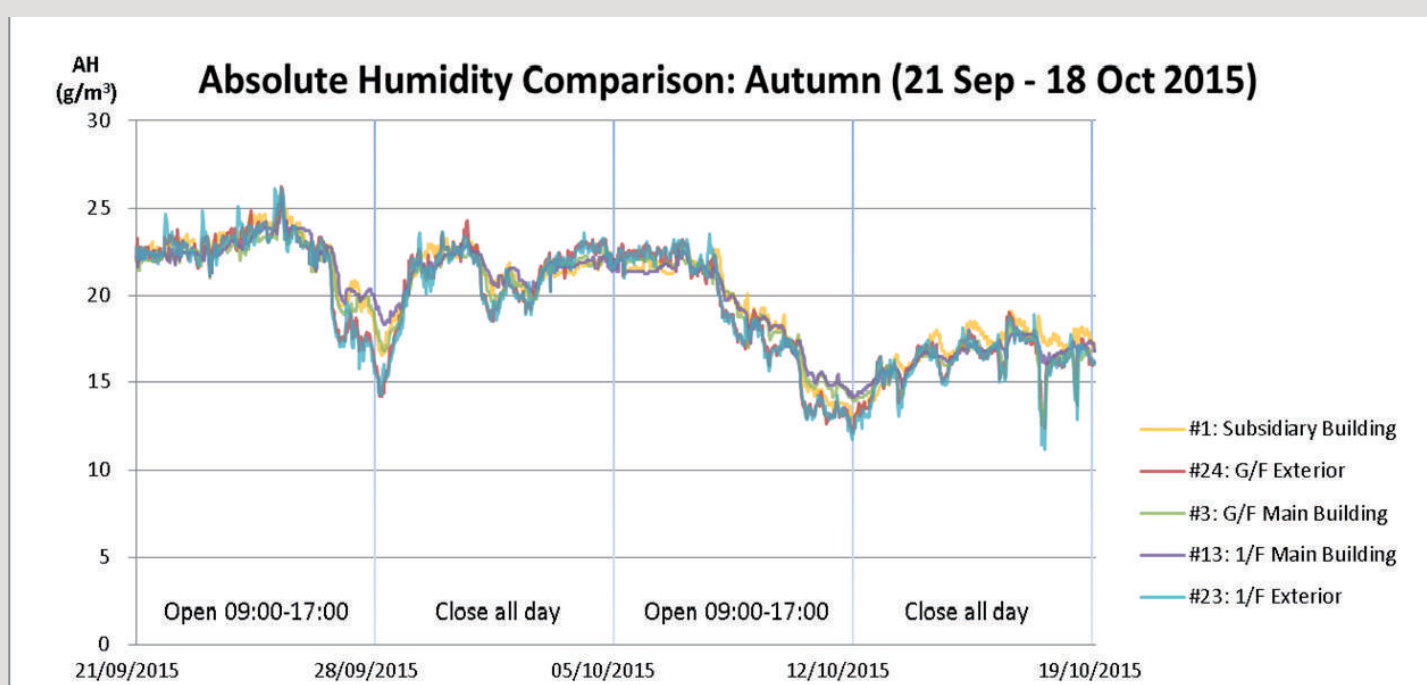
(5) The change in RH of 1/F, main building over the year (from sensor 13). Similar changing patterns are found at other locations.

### Effects of Air Circulation on Internal Environmental Conditions

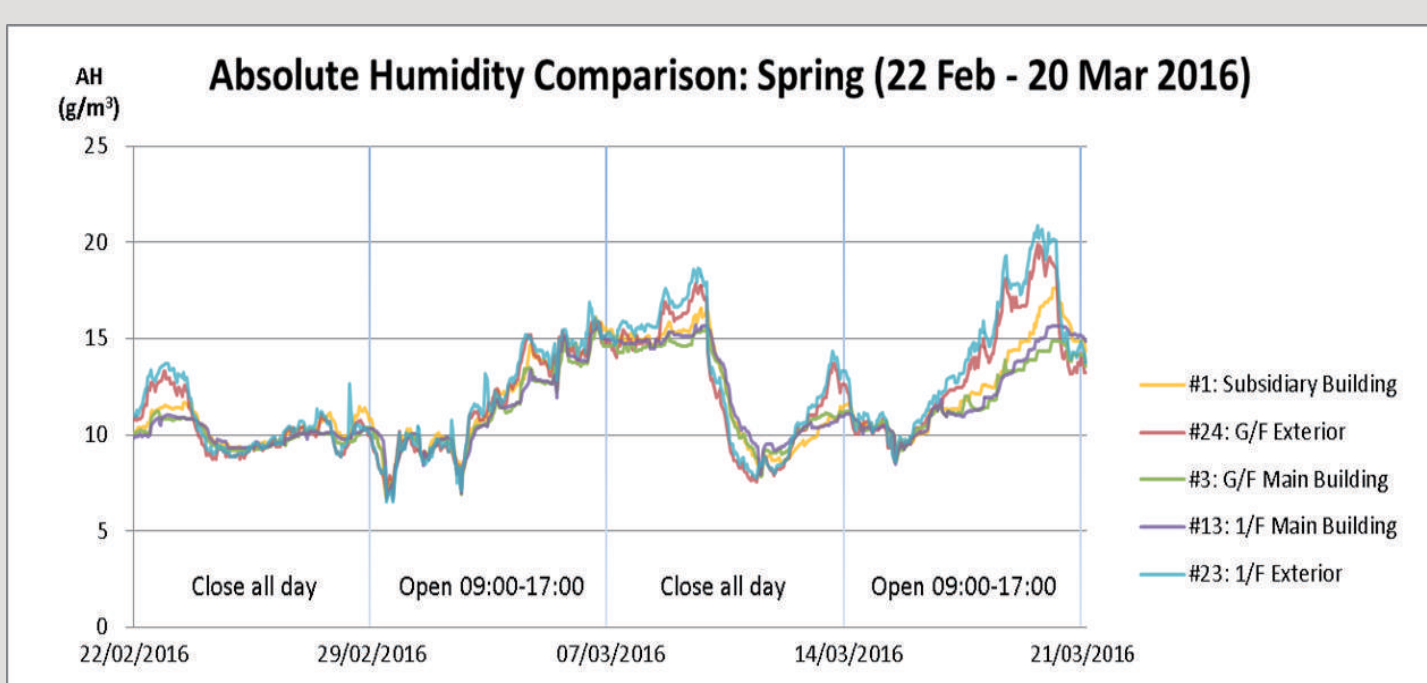
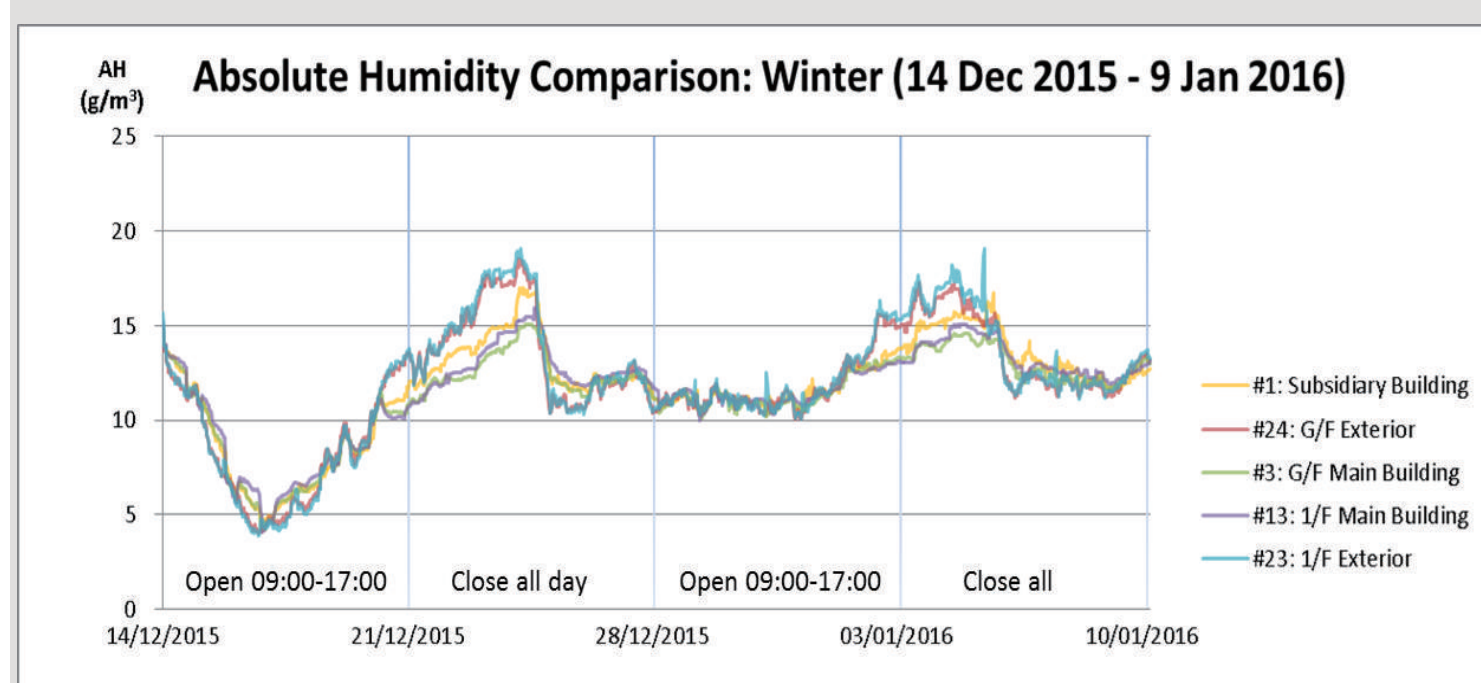
- AH fluctuations are minimised when the windows and doors are closed. Closed doors and windows create a less fluctuating environment, especially in terms of moisture content in the air (Figure 6-9).



6



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9

(6-9) Exterior and interior absolute humidity comparison of King Yin Lei over the four seasons.

## 4. Recommendation

1. If artefacts were to be displayed in King Yin Lei without the use of active means of environmental control, objects of different sensitivity should be placed at different locations on different floors:

Non-sensitive objects eg. ceramics, porcelain, stone	In all areas
Medium-sensitive or acclimatized objects eg. old wooden furniture in a stable condition	In main building: 1/F slightly more favourable than G/F
Sensitive objects eg. textile, paper, paintings and metal	In main building: In buffered showcases on G/F and 1/F

2. Static air and high air moisture content would induce mould growth inside the building. Balancing the security need as well as the potential hazard caused, it is recommended to open the windows and doors occasionally during the dry season in day time when the venue is patrolled by security guards regularly to allow active air circulation and prevent mould growth.

3. Portable dehumidifiers could be used with windows and doors closed on humid days during spring and summer to lower the interior RH.

