The University of Kitakyushu

Investigation on Thermal Performance in Japan's Local Station and Shopping District During Cold Season: Study Case of Kurosaki Arcade

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Introduction

Kurosaki Market's spatial and thermal condition is known to have minimum control and insulation for the alleys within it. This research delves in the thermal comfort conditions for the users who actively work in the unconditioned and semi outdoor area of kurosaki market and urban areas near the market and station.

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Literature Study

From previous studies,

- Outdoor thermal comfort is considered a highly valued parameter in urban planning, with thought of outdoor activities, biological health and wellbeing, social connectivity, and tourism. [1], [2], [3].
- It is known that a responsible building design considers the thermal environments within it so that it promotes productivity and don't trigger stress to the occupants [4].
- There is a strong relationship between people's comfort temperature in free-running buildings and the average outdoor temperature. This is most likely cause by the increase of thermal exposure experienced by the occupants. [4]
- There is a strong association of occupants' thermal expectations and knowledge about indoor climate resulting the context of outdoor conditions. This also shows that the less exposed people are to outdoor conditions, the more sensitive they are to thermal distress. For people who spend most of their daily time in concealed and controlled buildings, their knowledge of the outdoor conditions becomes further disconnected [4].
- But to analyze comfort in naturally ventilated areas is more difficult than in controlled areas. This requires a proper adaptive model analysis [5].
- Air conditioning systems within a building or complex strongly depends on its air temperature and absolute humidity [6].
- Aside from the adaptation of human biology, the key elements determining outdoor thermal comfort are urban geometry [7].

Method

- The 1st measurement, December 7th, 2023. The beginning of winter

- The 2nd measurement, January 13th, 2024. The middle of winter.

Method of data acquirement

TND Thermal Recorder

Thermal Globe Recorder

Anemometer

Method of data analysis

- PMV ASHRAE 55 (Berkeley)

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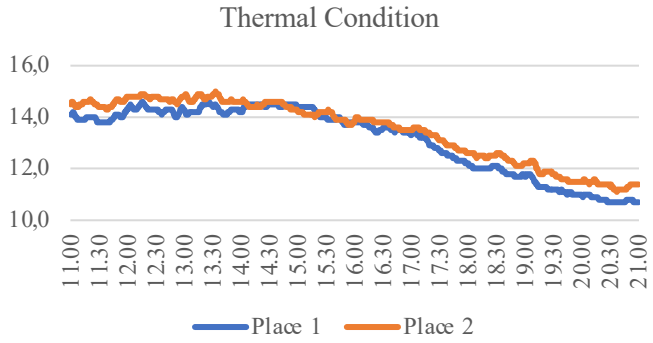
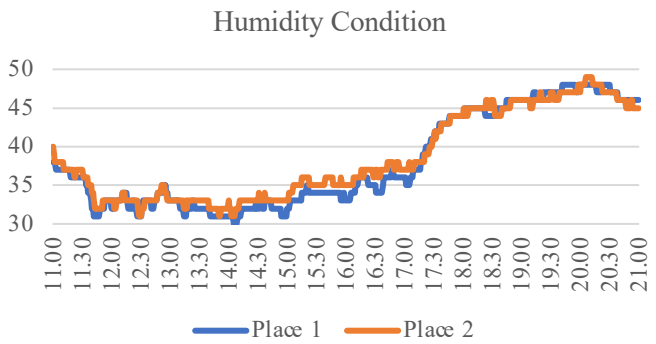
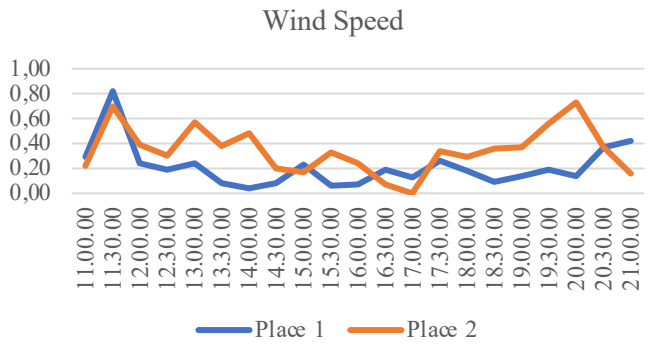
Result and Discussion

- the 1st measuring date







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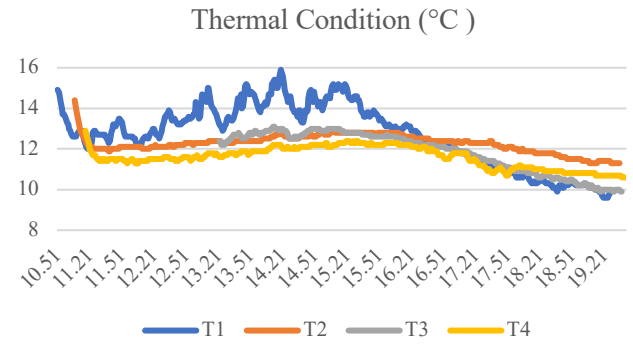

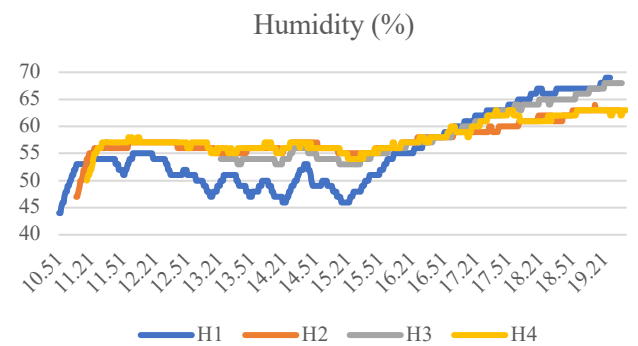

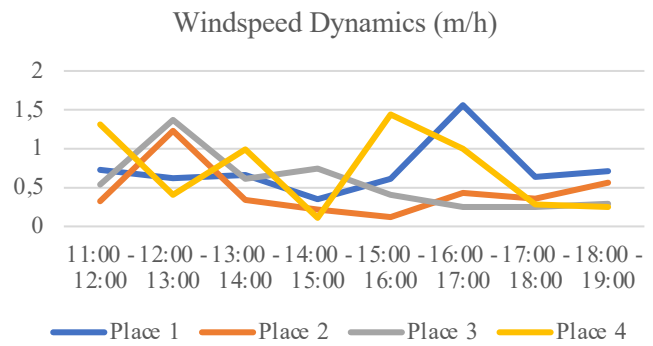

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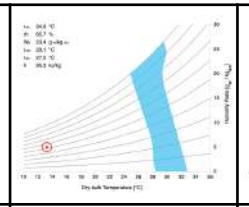
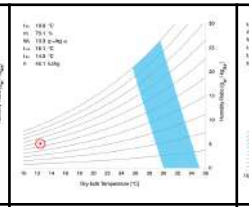
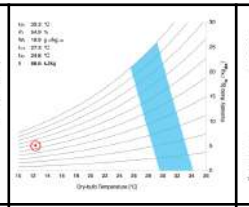
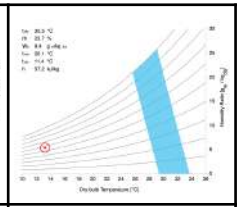
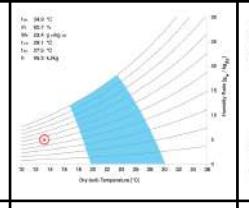
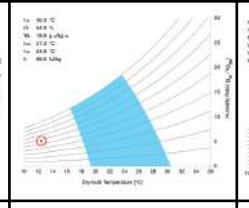
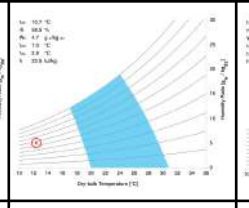
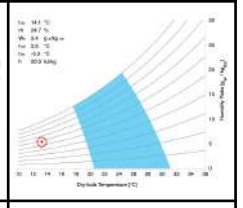
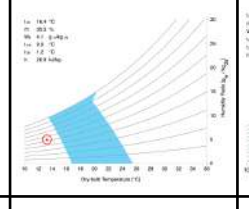
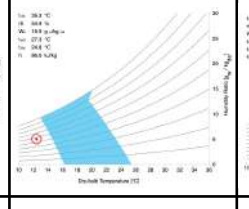
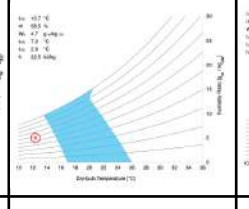
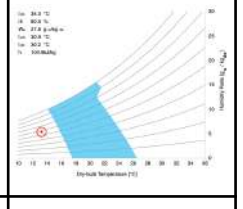
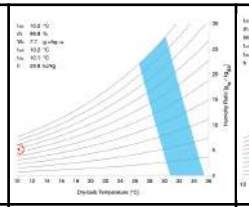
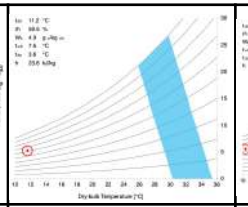
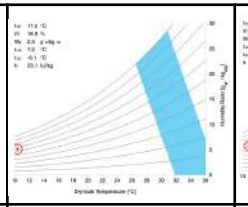
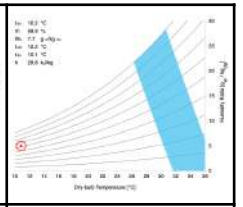
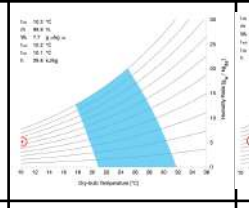
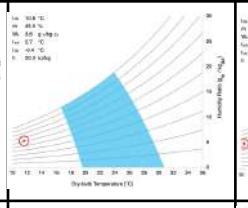
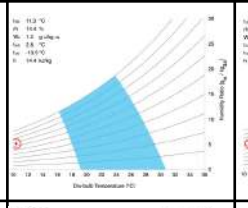
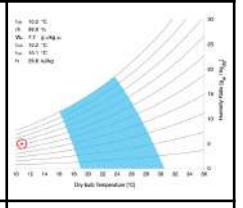
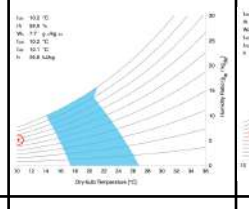
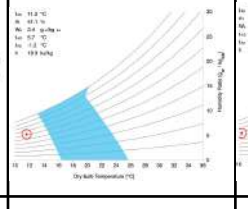
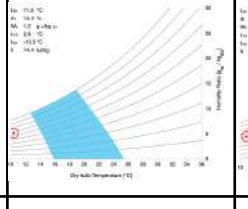
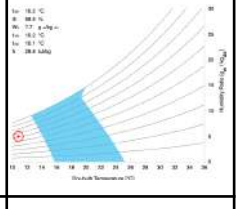
Result and Discussion

Seated				
Walking 3mph				
Walking 4mph				
	Place 1	Place 2	Place 3	Place 4

- Day time

Seated				
Walking 3mph				
Walking 4mph				
	Place 1	Place 2	Place 3	Place 4

- Night time

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Conclusion

Based on the research done, it is found that :

1. The thermal condition during winter within the Kurosaki area has minimum to zero insulation which affects the comfort on thermal condition within Kurosaki's area of activity.

2. Based on the data collected from the first measurement date, it is evident that the climatic conditions in these areas are quite similar. Throughout the day, temperatures range between 13-15 degrees Celsius, accompanied by humidity levels ranging from 30-40%. Similarly, nighttime temperatures range from 10-13 degrees Celsius, with humidity ranging from 44-49%. These conditions, when compared to established standards such as KLAMOTO and ASHRAE, fall short of the criteria for ideal environmental conditions.

3. But even with the current uncomfortable condition, people still try to make do and adapt to its condition. Giving compensation and adapting up to 7 degrees Celcius under the standard thermal comfort limitation

4. The most crowded and highly used area, the urban space in front of Kurosaki station, has the warmest thermal condition based on the second measurement date. The warmest place is the place with minimum building placement around it and it shows that the availability of building near certain outdoor or semi outdoor area might affect block the conditions of windspeed, but it also affects the presence of sun spots, hence making the area much cooler in the day. But at night, without the presence of sun, uncovered outdoor areas such as this are prone to lower thermal conditions at night.

5. the semi outdoor area of Kurosaki market which has more buildings surrounding it has a more stable thermal condition that the point outside of its alleys.

6. Even so the stable condition are constant with much cooler condition in the noon than the station front point but still warmer if compared with the same point at night.

7. The thermal comfort condition other than insulation and clothing also depends on the user's activity and the least comfortable activity done is actually faced by the shop keepers in the market who is seated on the outside area of their stores.

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