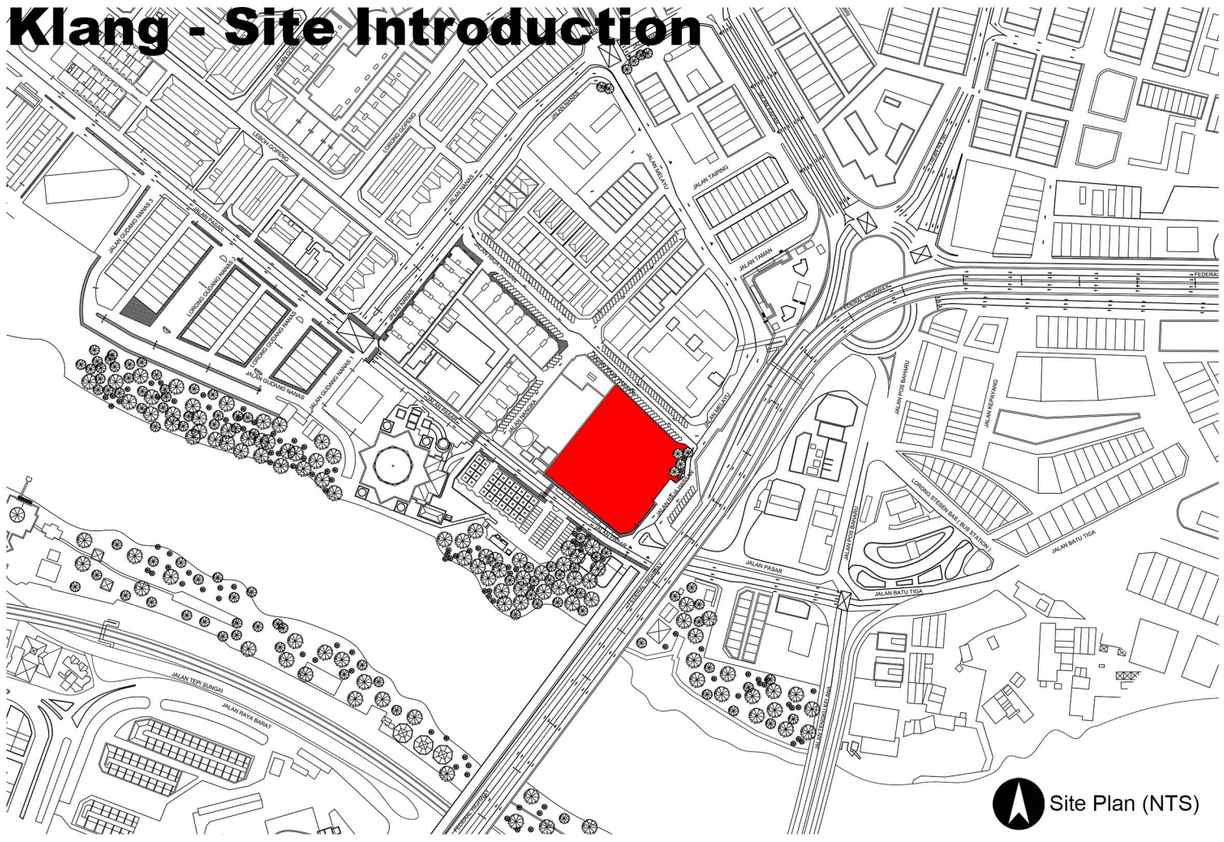
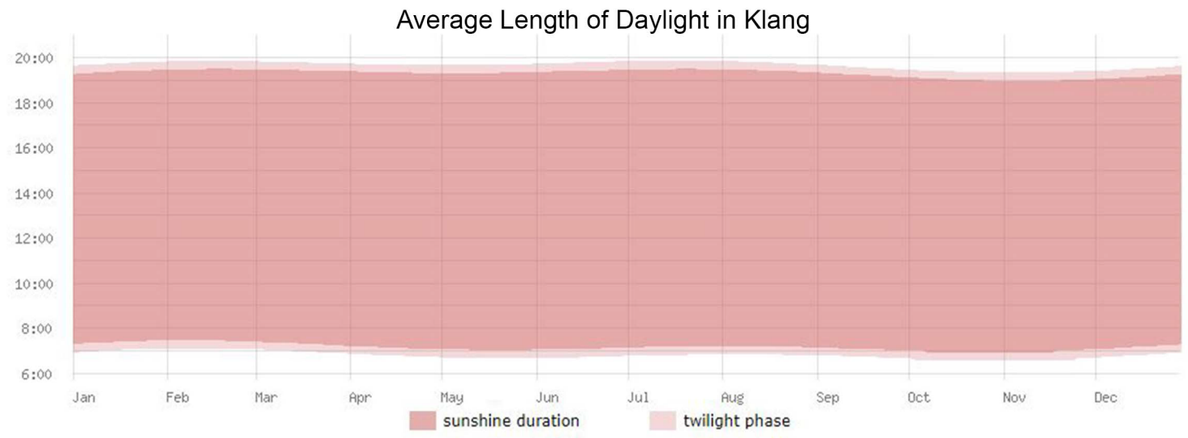
Kurrimbaccus Ally 0340629 Ong Ker Sin 0321719 Tay Jia Jian 0315508 Yang Jing Loo 0323066

# Klang - Site Introduction



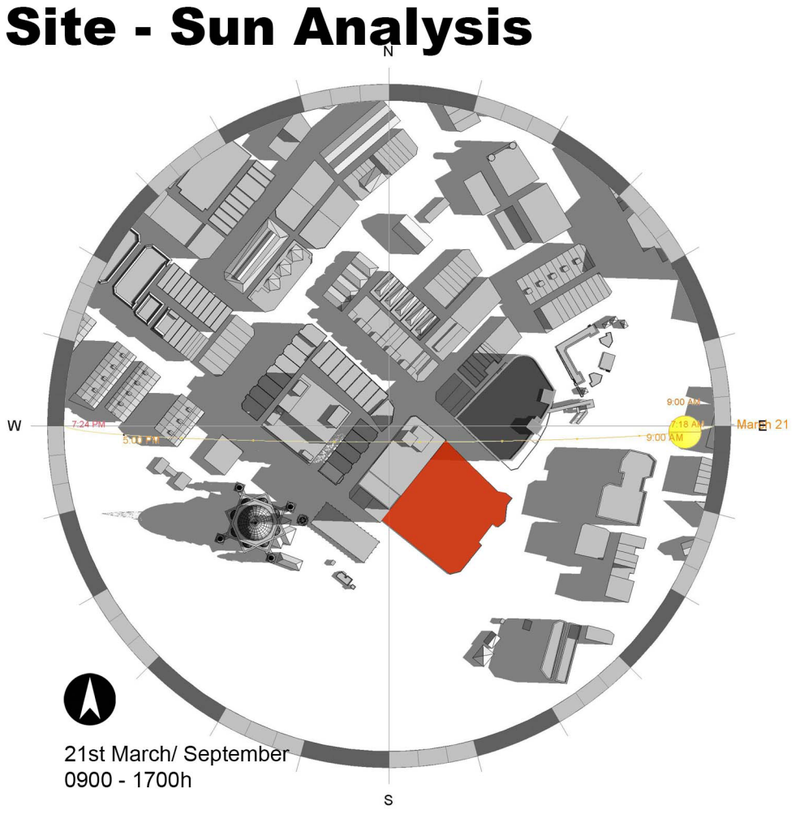

Klang is strategically separated by Klang River, divided into North Klang & South Klang. The located site (3.04°N 101.4°E) is highlighted in red, located along Jalan Pasar and Jalan Raja Hassan with context of Masjid Bandar Diraja Klang, Kota bridge, espressway and mall. There is an increasing amount of abondoned and unoccupied shops due to the relocation of Klang bus terminal. Therefore, the proposed building is a Civic Center for Majlis Bandaraya Klang (MBK) to revitalise the place.

Times for sunrise and sunset in Malaysia does not vary substantially throughout the year due to its location close to equator. Unlike the Nordic countries of Europe with extreme difference of daylight throughout the year. The graph below shows the average length of daylight in Klang stays between 12 hours.



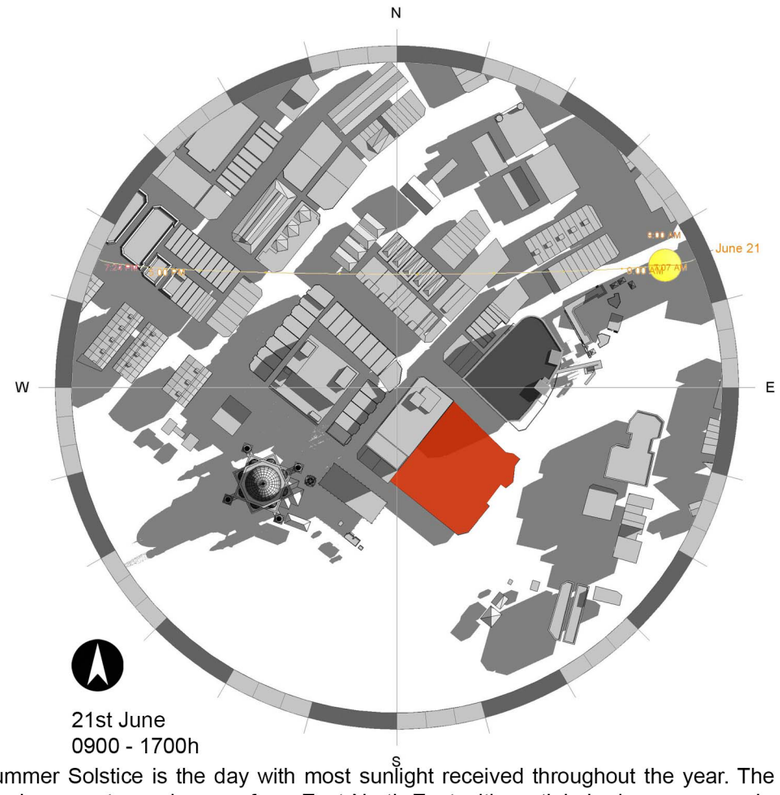

Source: https://www.worlddata.info

# Site - Sun Analysis



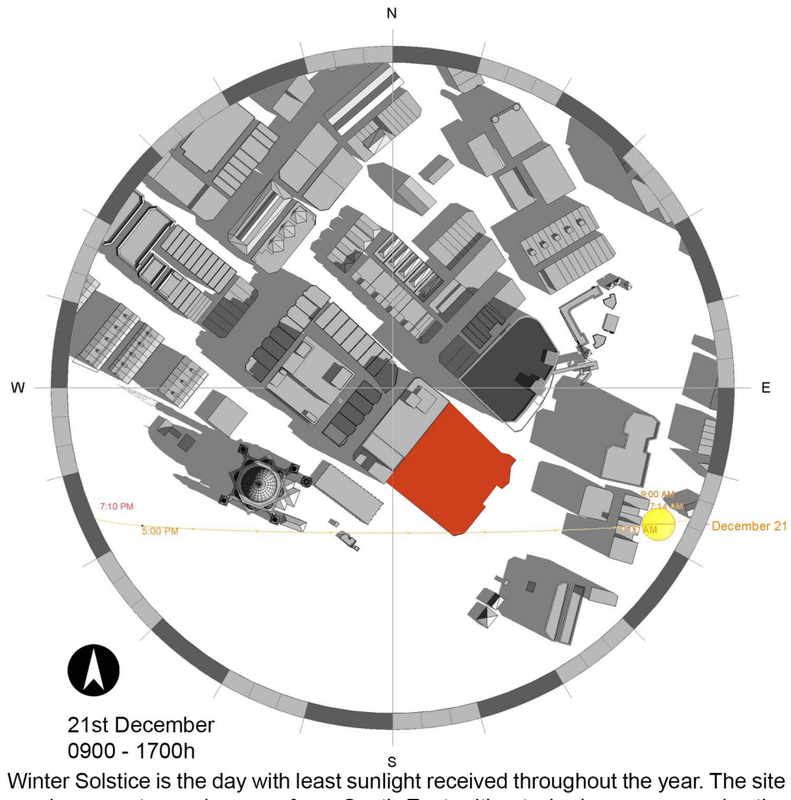

21st March/ September
0900 - 1700h

The site receives most morning sun from East, with minor shadow coverage from the building behind. Evening sun is partially shaded by the adjacent building.




21st June
0900 - 1700h

Summer Solstice is the day with most sunlight received throughout the year. The site receives most morning sun from East-North-East with partial shadow coverage by the building behind. Evening sun is partially shaded by the adjacent building.

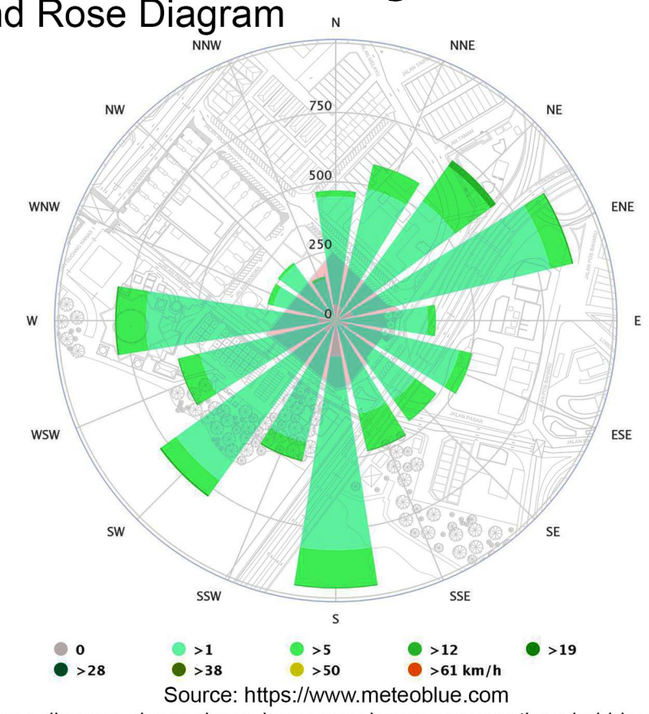



21st December
0900 - 1700h

Winter Solstice is the day with least sunlight received throughout the year. The site receives most morning sun from South-East without shadow coverage by the surrounding buildings. Evening sun is partially shaded by the adjacent building. Shading device is needed to improve the building's thermal comfort.

# Site - Wind Analysis

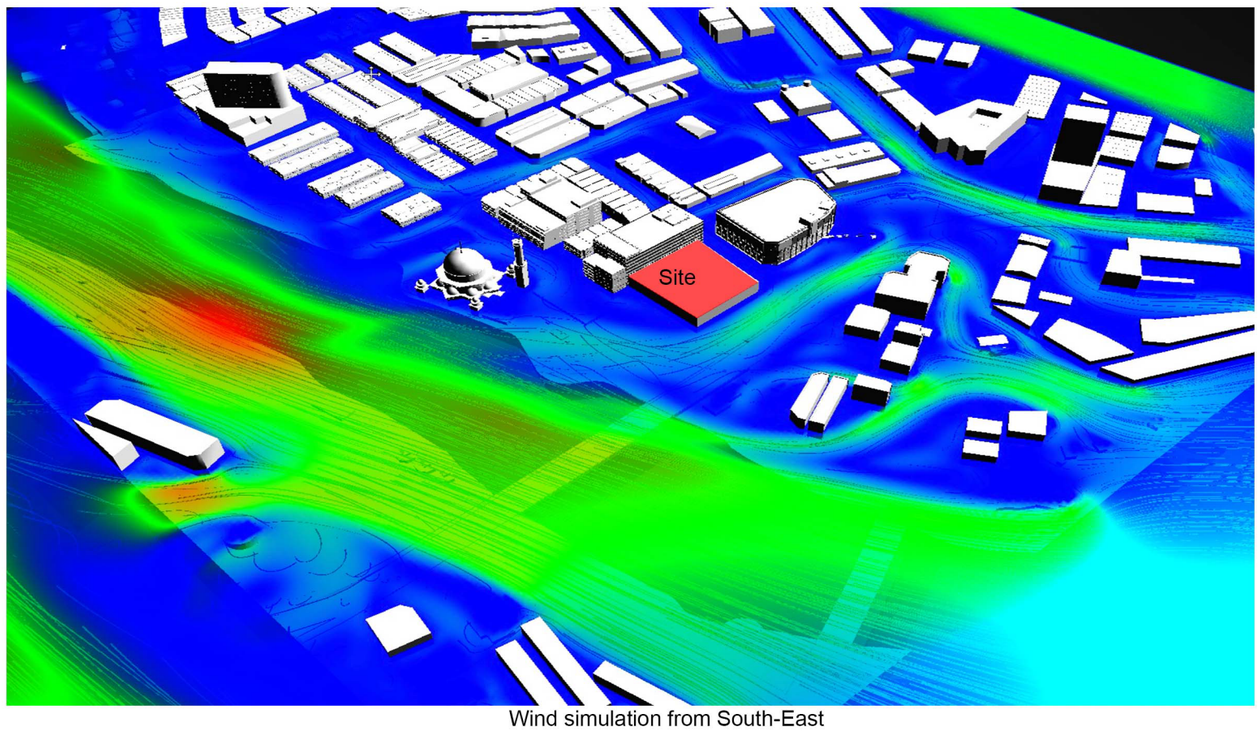
## Wind Rose Diagram




Source: https://www.meteoblue.com

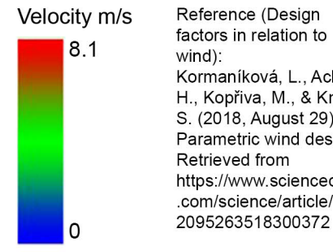
Wind rose diagram above shows how many hours per year the wind blows from the indicated directions. The wind from South has the longest hours (129h/ year) with 0 wind speed. Whereas the wind from East-North-East is the most frequent (732h/ year) with the speed of 1km/ h. The strongest wind speed recorded was from North-East with a speed exceeding 12km/h, lasted for 25h.

## Observation:



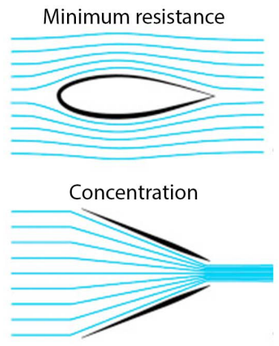

Wind simulation from South-East

Wind simulation from South-East: The wind simulation is run on 1m from ground level with a speed of 2.45m/s. Prevailing wind from South-East results in an air flow with an average speed of 4.05 m/s across the South-East of the site. According to MS1525:2014, air speed of 0.5-1.5m/s is considered acceptable for indoor air quality and human comfort level. Therefore, an efficient gizmo is needed not only to control glare but also to control the air flow into the building.

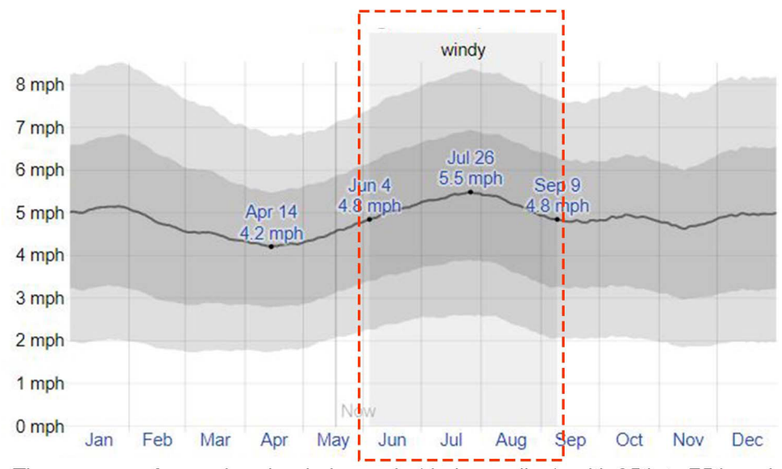



Reference (Design factors in relation to wind):
Kormaníková, L., Achten, H., Kopřiva, M., & Kmeť, S. (2018, August 29). Parametric wind design. Retrieved from https://www.sciencedirect.com/science/article/pii/S2095263518300372

**Design factors in relation to wind:**
Architecture represents an obstacle to the wind flow, affecting the flow pattern and the speed. The following five principles categorize basic options how architecture can deal with wind (top view): Minimum resistance, Concentration, Diffusion, Deflection and Materialization.

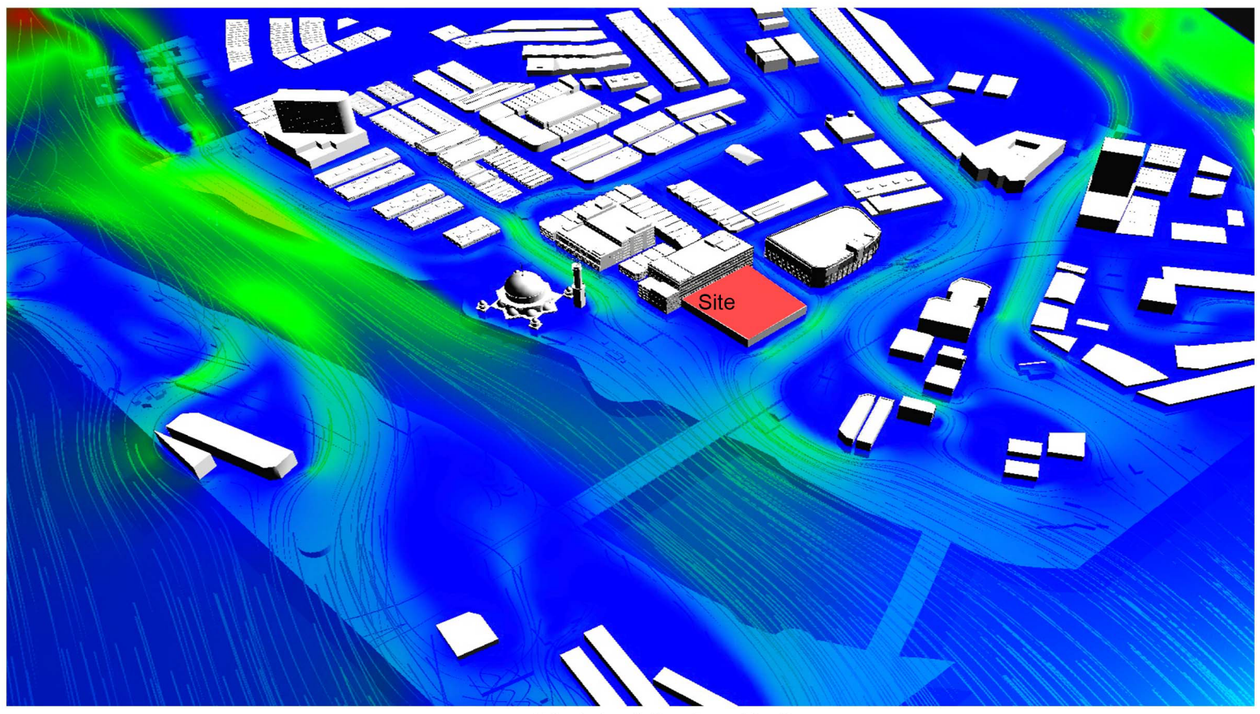



## Average Wind Speed



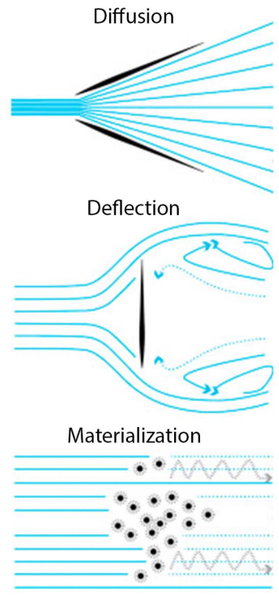

The average of mean hourly wind speeds (dark gray line), with 25th to 75th and 10th to 90th percentile bands. Source: https://weatherspark.com

Diagram above shows wind speed in Klang experiences mild seasonal variation over the course of the year. The windier part of the year lasts for 3 months, from June to September, with average wind speeds of more than 4.8 mph (7.7km/h). The windiest month is July, with an average hourly wind speed of 5.5 mph (8.9km/h). The calmest month is April, with an average hourly wind speed of 4.2 mph (6.8km/h).




Wind simulation from South

Wind simulation from South: The wind simulation is run on 1m from ground level with a speed of 2.45 m/s. Prevailing wind from South is blocked by surrounding context: the Kota Bridge and Federal Highway. An efficient gizmo is needed to accelerate or improve air flow to allow cross ventilation through the building.




Out of the five principles mentioned above, 'Deflection' is the most applicable principle in which it can be done by utilizing double skin façade system. The system of double skin is used for the passive ventilation to create a funnel effect and direct the wind towards the buildings.

Kurrimbaccus Ally 0340629 Ong Ker Sin 0321719 Tay Jia Jian 0315508 Yang Jing Loo 0323066

# Project Methodology

## Daylight Factor (DF)

Malaysian Standards MS1525:2014 guidelines stated that good lighting system have to consider the aspects of space orientation, organization, (form and size) physical properties and optional properties of glazing through which daylight will transmit or penetrate. Interior floor, wall and ceiling surface properties such as color and reflectivity. Visual contrast between walls and ceilings of adjacent surfaces. Daylight factor is indicated in percentage describes the daylight distribution, penetration and intensity.

| DF (%) | Lighting | Glare | Thermal comfort |
|---|---|---|---|
| > 6.0 | Intolerable | Intolerable | Uncomfortable |
| 3.5 - 6.0 | Tolerable | Uncomfortable | Tolerable |
| 1.0 - 3.5 | Acceptable | Acceptable | Acceptable |
| < 1.0 | Perceptible | Imperceptible | Acceptable |

Table: Daylight Factors and Impact (above)

$$DF = \frac{E_{internal}}{E_{external}} \times 100\ \%$$

Daylight factor (DF) of 1%-3.5% is considered acceptable based on the Malaysian Standards as it receives comfort daylight quality into space, sufficient glare and thermal comfort.

| Sky conditions | | | |
|---|---|---|---|
| **Sky type** | **Description** | **Cloud cover (%)** | **Sky Illuminance (lux)** |
| Standard overcast | Sun not visible;sky covered with thick, milky white cloud | 100 | 5 000 - 20 000 |
| Cloudy | Sky partially covered by cloud | > 70 | 20 000 - 100 000 |
| Intermediate | Sky mostly covered with 30 % to 70 % cloud | 30 - 70 | 30 000 - 100 000 |
| Clear blue sky | Sky with almost no cloud | < 30 | 50 000 - 100 000 |

Table: Sky Condition

$$1.0 = \frac{E_{internal}}{30{,}000} \times 100\ \%$$

$$E_{internal} = 300\ \text{Lux}$$

$$3.5 = \frac{E_{internal}}{30{,}000} \times 100\ \%$$

$$E_{internal} = 1050\ \text{Lux}$$

Based on the Malaysian Standards, the sky condition in Malaysia is classified as Intermediate. The internal illuminance (lux) is 300 Lux – 1050 Lux according to the acceptable Daylight factor.

## Air Velocity

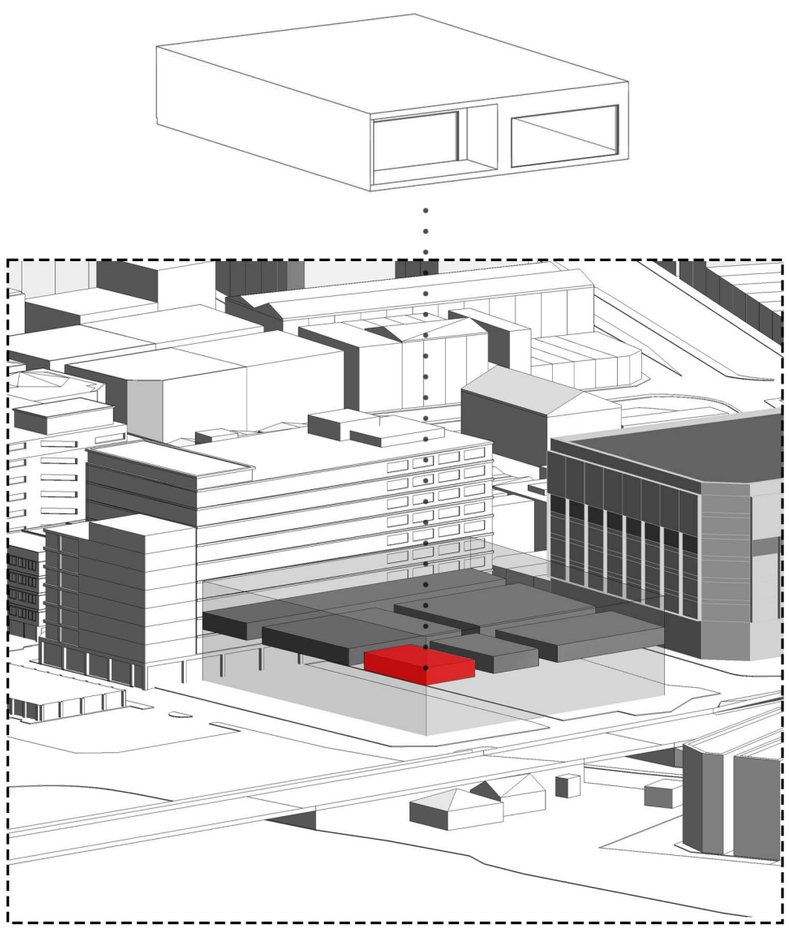
Malaysian Standards stated that air movement affects thermal comfort. The presence of air movement enhances evaporative and convective cooling from the skin and can further increase our thermal comfort. The table provides a guide on the impact of air speed on occupant's sensation, with an air speed between 0.5m/s – 1.5m/s is classified as human comfort level and acceptable indoor air quality. The greater the air velocity, the greater the heat exchange between people in a space and the air around its surroundings.

| Air speed (m/s) | Mechanical effect | Occupant sensation |
|---|---|---|
| ≤ 0.25 | Smoke (from cigarette) indicates movement | Unnoticed, except at low air temperatures |
| 0.25 - 0.5 | Flame from a candle flickers | Feels fresh at comfortable temperatures, but draughty at cool temperatures |
| 0.5 - 1.0 | Loose papers may be moved. Equivalent to walking speed | Generally pleasant when comfortable or warm, but causing constant awareness of air movement |
| 1.0 - 1.5 | Too fast for deskwork with loose papers | Acceptable in warm conditions but can be from slightly to annoyingly draughty |
| > 1.5 | Equivalent to a fast walking speed | Acceptable only in very hot and humid conditions when no other relief is available. Requires corrective measures if comfort and productivity are to be maintained |

Table: Impact of Air Speed on Occupants

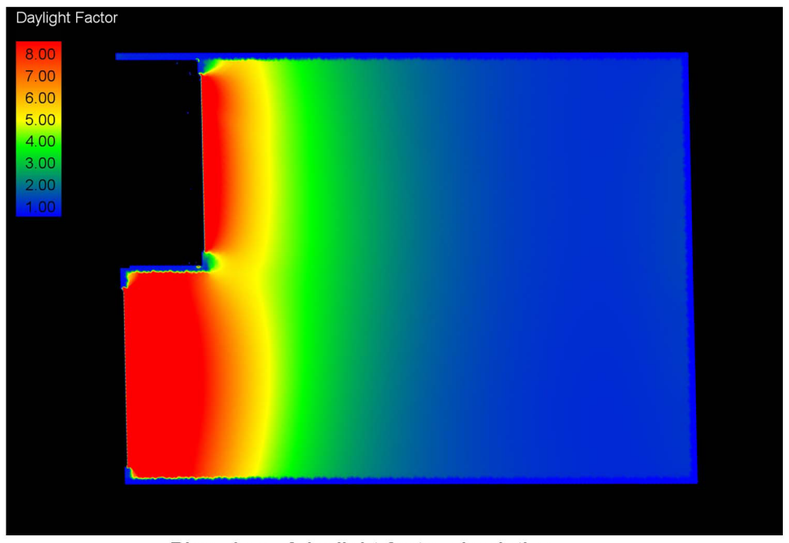
# Baseline Model

## Site Isometric

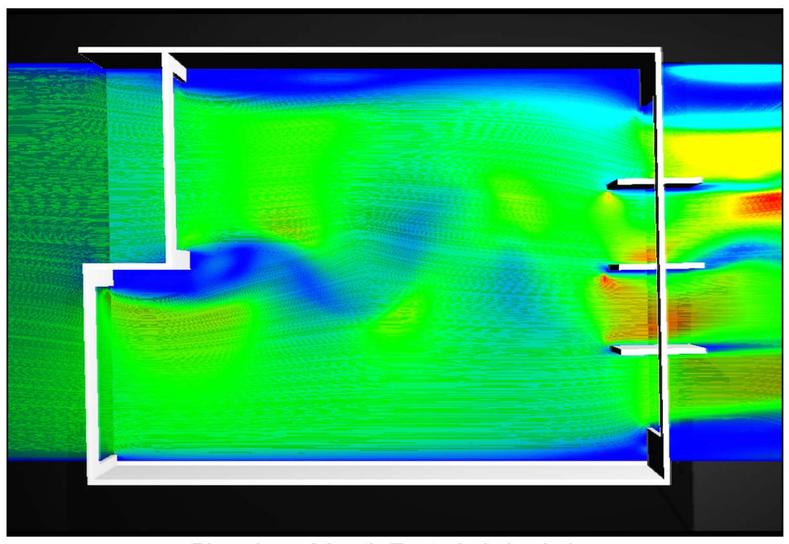


The chosen area as highlighted in the Isometric above is an exhibition space of the Civic Center located at third floor. South-East facade of the building is the most critical side as it receives the most direct sunlight without shadow coverage from the surrounding context. Gizmo is to be proposed and implemented at this side to improve the building's thermal comfort as well as the energy efficiency.

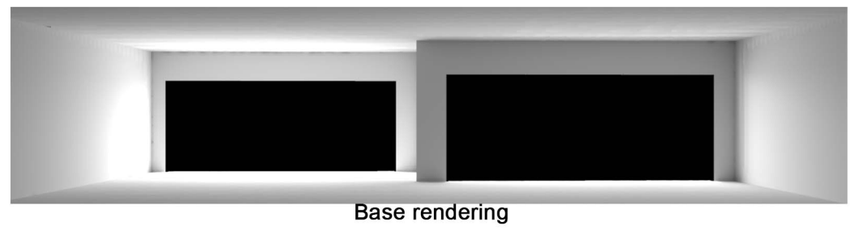
## Baseline Model Simulation



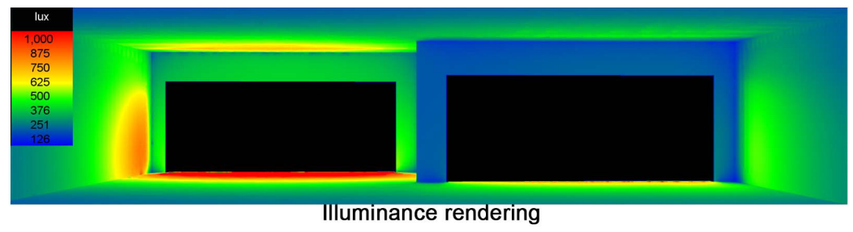

Plan view of daylight factor simulation



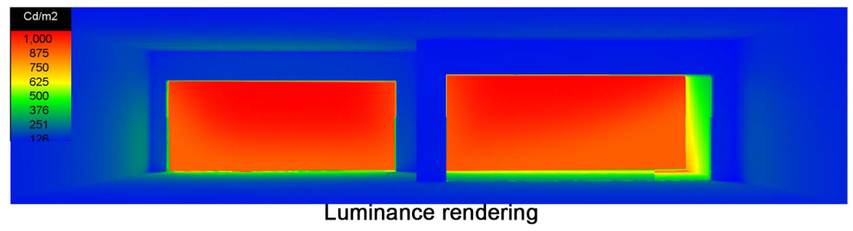
Plan view of South-East wind simulation



Base rendering




Illuminance rendering




Luminance rendering

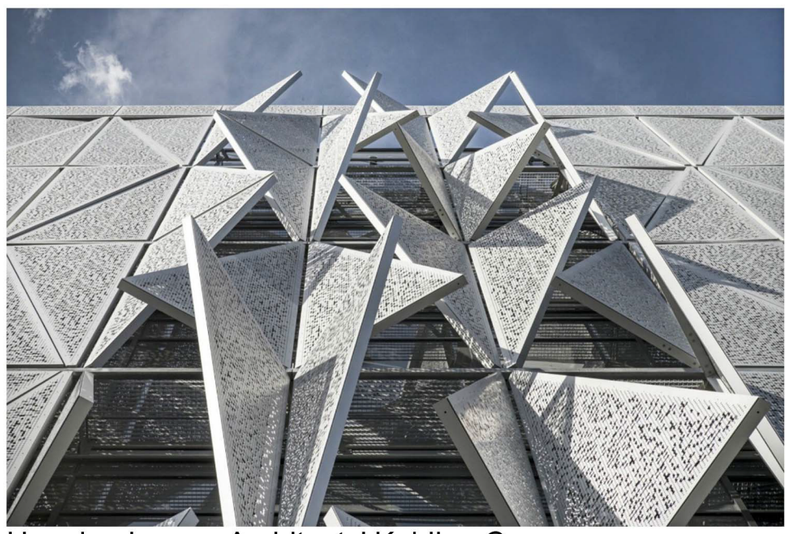
### Daylight Factor Simulation

The daylight factor, illuminance and luminance simulations were generated using Velux. It shows the baseline model receives an average daylight factor of 2.7%. But the average daylight factor within 3m from the opening is 7.0% which has already exceeded the acceptable range of 1-3.5% based on MS1525:2014. Therefore, an efficient gizmo is to be proposed to filter the sunlight and glare to ensure human thermal comfort.

### Wind Simulation

Wind simulation was generated using Flow Design. The simulation is run on 1m from ground with a speed of **2.45 m/s**.It shows that air velocity within the room is around 4.0m/s, in which has already exceeded the acceptable range of 0.5-1.5m/s based on MS1525:2014. Therefore, an efficient gizmo is to be proposed to allow optimal cross ventilation and ensure pleasant and comfortable internal environment.

# Precedent Study

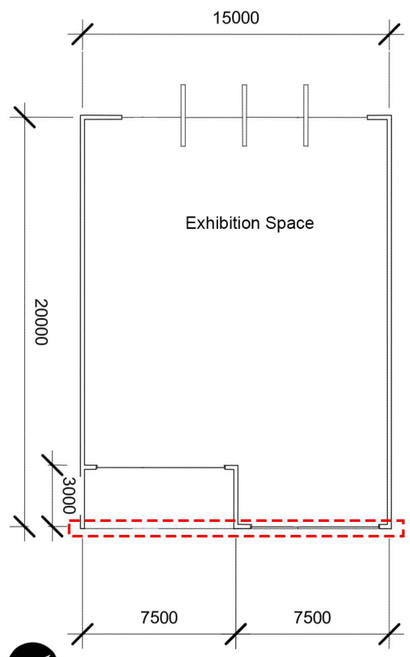


Henning Larsen Architects' Kolding Campus

This campus a has continuous glass façade with an insulating system made up of 1600 steel sunshades to bring quality lighting for the lectures and laboratories that take place inside the building. These perforated modular elements are mobile and mounted on a frame, with sensors constantly monitoring light and temperature levels and a mechanical system for varying their orientation to maintain perfect climatic conditions.

| Aluminum | Properties | Concrete |
|---|---|---|
| High tensile strength. Durable due to its long lifespan. | **Durability** | Durable. Depending on the exposure environment and properties desires. |
| Lightweight. | **Weight** | Heavyweight. |
| Surfaces able to expose in harsh weather. | **Material sustainability** | Resist weathering action and chemicals. |
| Aluminum efficient in conducting heat and reducing heat easily. | **Thermal Conductivity** | High conductivity. |
| Reflectivity makes aluminum ideal as an insulating material to protect against the sun's rays. | **Reflectivity** | Its uniform surface texture allow maximum light reflectance. |
| Ductile and has low melting point and density. | **Ductility** | Concrete is brittle. |
| High water resistant. | **Water resistance** | Waterproof material. |
| Excellent resistance to corrosion due to its material properties. | **Corrosion resistance** | Concrete high in alkaline material, it provides protection against corrosion of surfaces. |
| Sound barrier. | **Acoustic performance** | Reduce airborne noise transmission. |
| Long-term available. | **Material availability** | Long-term available. |
| Recycle without degradation. | **Recyclability** | Longer recycling process. |
| Low maintenance than other metals. | **Maintenance** | Low maintenance/ surface protection. |

# Gizmo Proposal

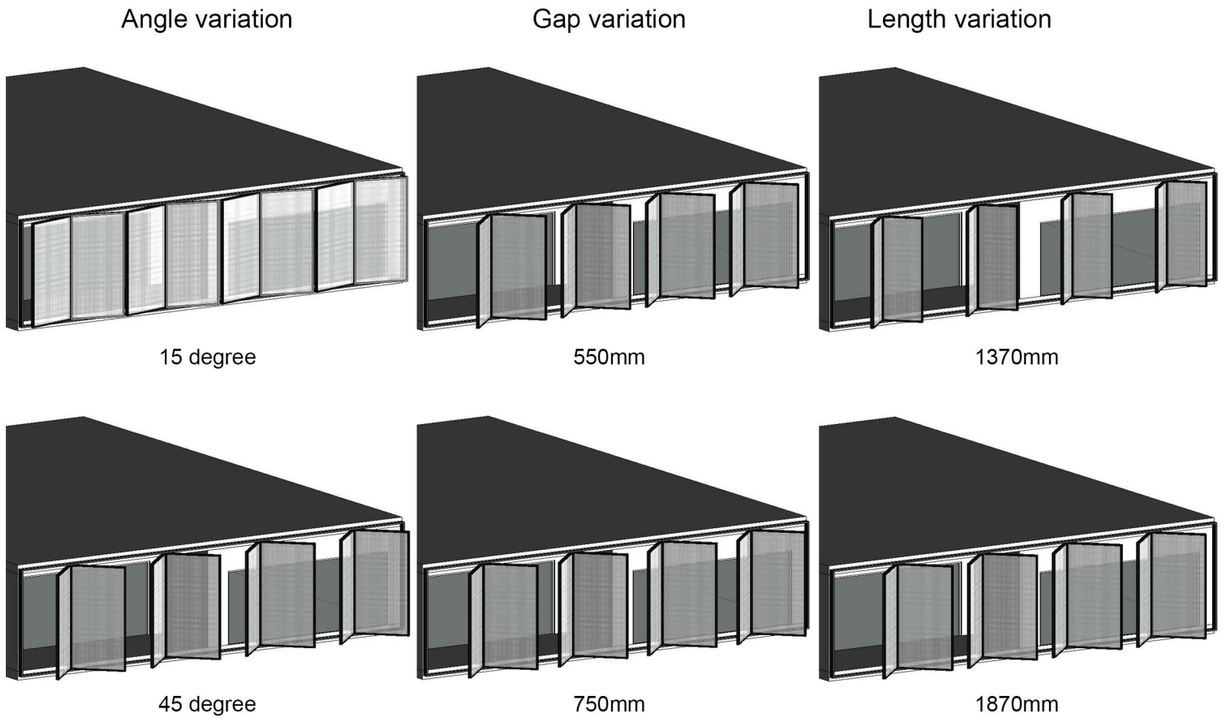



Schematic Floor Plan for Simulation (1:300)

The South-East facade of the building recieves the most direct sunlight from 0900-1200h without any shadow coverage from surrounding context. Therefore, the gizmo proposed is of 3550mm height, covering the South-East facade of the exhibition space. The gizmo is designed to filter glare for a naturally but indirectly-lit environment, while at the same time, it allows the cross ventilation to flow through the building.

The framework of the daylight simulation and wind simulation analysis intend to create an optimal design of the proposed gizmo. The optimal design is to block direct sunlight and accelerate air flow from South-East direction in order to improve thermal comfort and ventilation of the intended space.

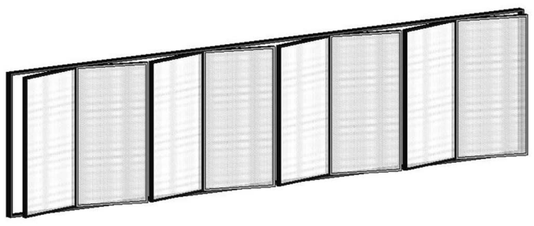
Models of three variables which are: angle, gap and length will be simulated for daylight factor and wind analysis. Three configurations were designed for each variable in order to study their respective results. Optimal gizmo will be generated by selecting configurations that are efficient in achieving the framework.

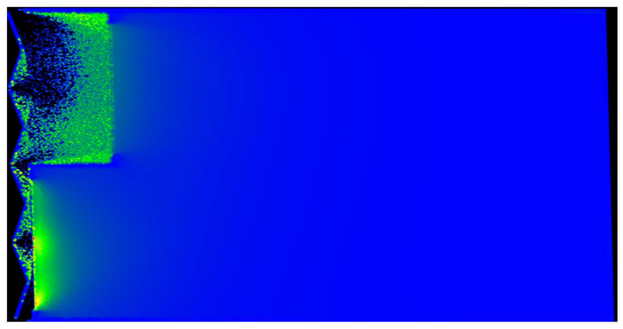


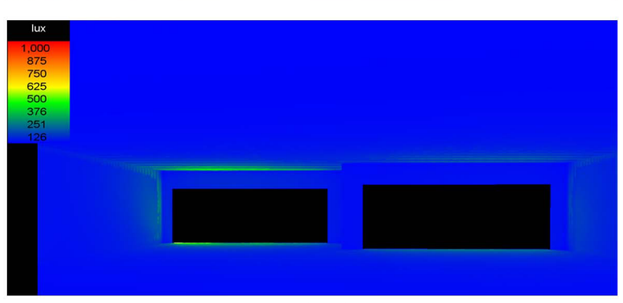
Kurrimbaccus Ally 0340629 Ong Ker Sin 0321719 Tay Jia Jian 0315508 Yang Jing Loo 0323066

# Gizmo First Series Simulation (Angle Variation)

15° Angle





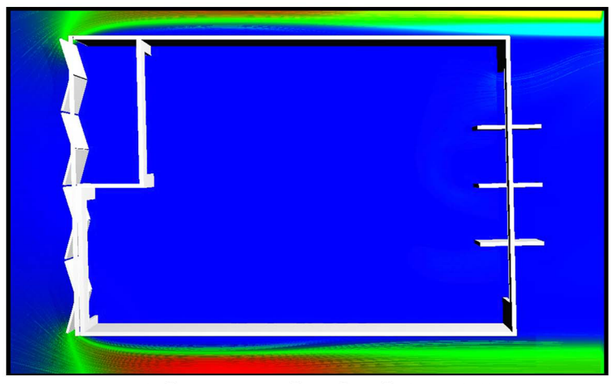



**A1: DAYLIGHT FACTOR SIMULATION**

15 degree gizmo blocks most of the daylight into the room with <1% DF within 3m from the opening.

**A1: ILLUMINANCE (FLUX) SIMULATION**

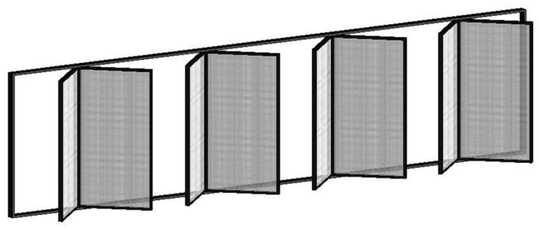
Low illuminance causes insufficient natural lighting into the room.

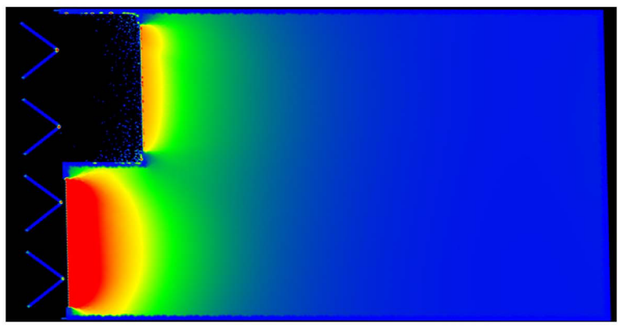


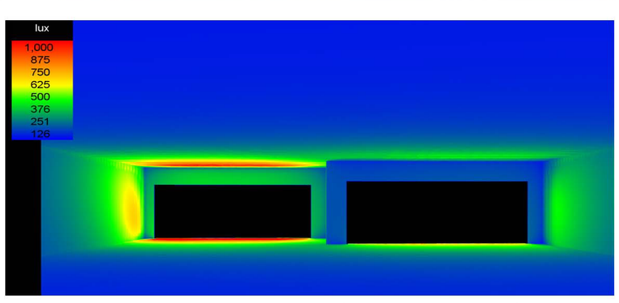
**A1: WIND SIMULATION OF SPEED 2.45 m/s**

15 degree angle gizmo has blocked wind flow and cross ventilation into the room.

45° Angle





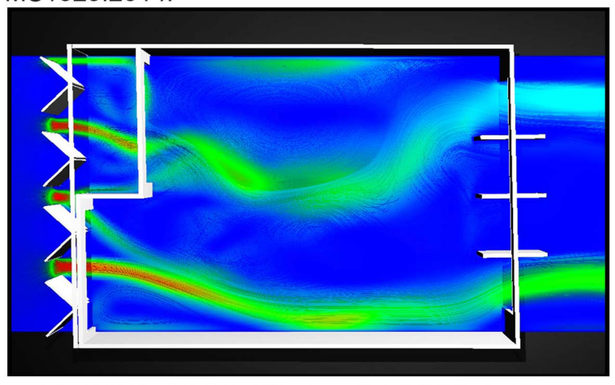



**A2: DAYLIGHT FACTOR SIMULATION**

45 degree gizmo allows around 2.9% of DF within 3m from the opening.

**A2: ILLUMINANCE (FLUX) SIMULATION**

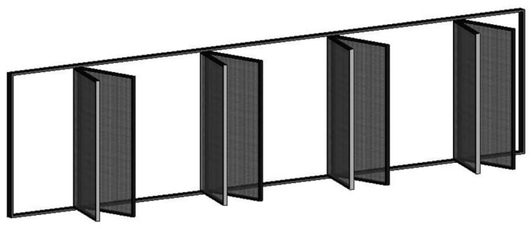
The gizmo allows around 270 lux illuminance into the room, which is slightly below the standards stated in MS1525:2014.

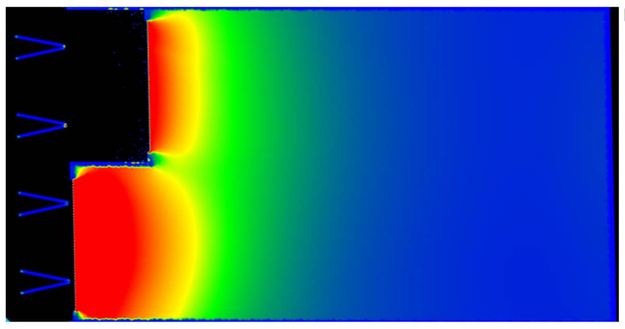


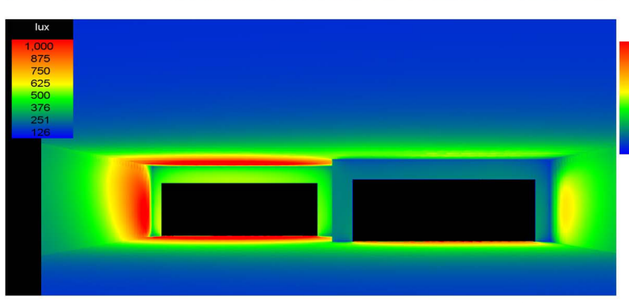
**A2: WIND SIMULATION OF SPEED 2.45 m/s**

Acceptable wind flow and speed with minor turbulence at the middle of the room.

75° Angle





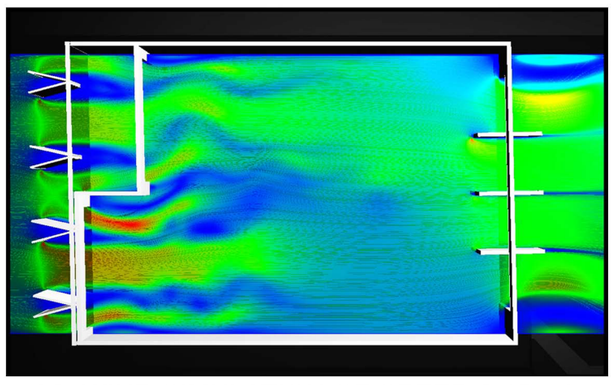



**A3: DAYLIGHT FACTOR SIMULATION**

75 degree gizmo causes an unacceptable DF around 4.8% within 3m from the opening.

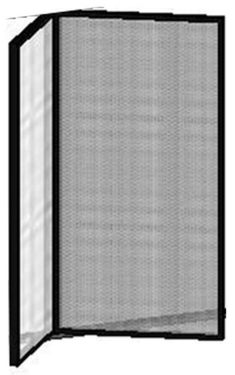
**A3: ILLUMINANCE (FLUX) SIMULATION**

75 degree gizmo allows 320 lux illuminance into the room, which is considered acceptable.



**A3: WIND SIMULATION OF SPEED 2.45 m/s**

Unacceptable wind flow and speed with excessive turbulence throughout the room. Almost the entire room is covered with green area (velocity).






**Daylight Simulation Analysis**

By comparing the daylight factor simulations of A1, A2 and A3, gizmo A1 and A3 are considered unacceptable, as A1 has relatively low DF and A3 has relatively high DF. A2 has a DF around 2.9% with acceptable glare within 3m from the openings.




According to the illuminance simulations of A1,A2 and A3, A2 and A3 are considered acceptable with illuminance of 270 lux and 320 lux respectively. Iluminance of A1 is below the standards.

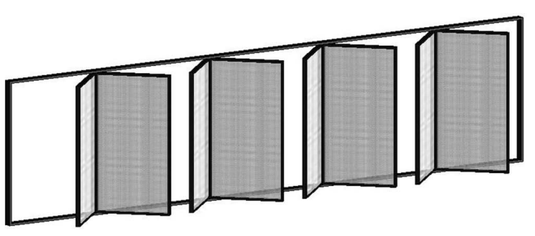


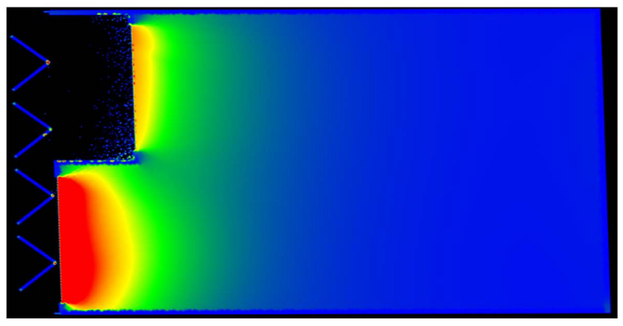

**Wind Simulation Analysis**

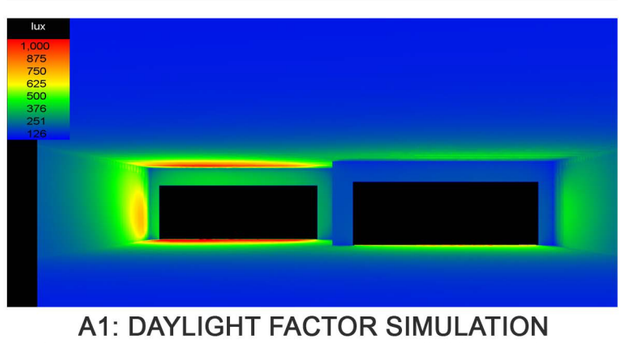
By comparing all the wind simulations, A1 and A3 have unacceptable wind flow and speed. A1 has blocked the natural wind from entering the room, and A3 causes high wind velocity and turbulence throughout the room. Therefore, A2 simulation with 45 degree angle gizmo is better that allows acceptable wind flow and speed.

# Gizmo Second Series Simulation (Gap Variation)

550mm Gap





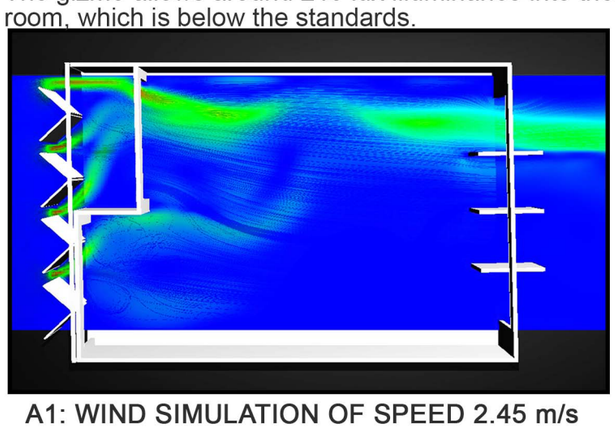



**A1: DAYLIGHT FACTOR SIMULATION**

550mm gap gizmo allows around 2.3% of DF with acceptable glare within 3m from the opening.

**A1: ILLUMINANCE (FLUX) SIMULATION**

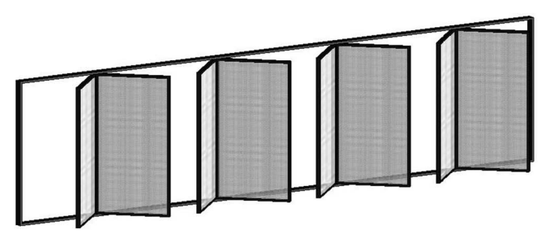
The gizmo allows around 210 lux illuminance into the room, which is below the standards.

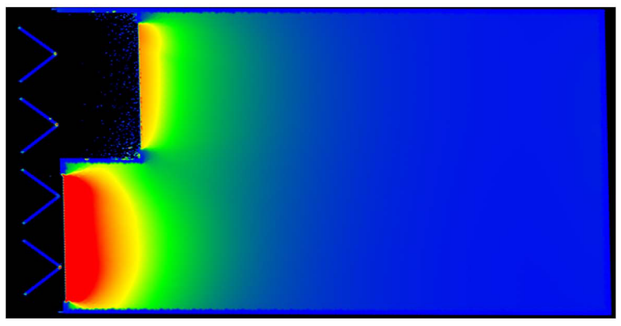


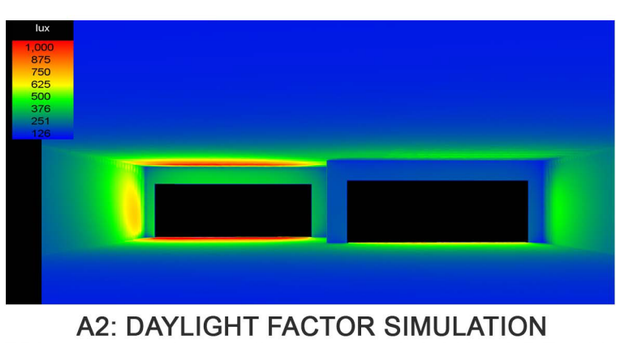
**A1: WIND SIMULATION OF SPEED 2.45 m/s**

Acceptable wind flow and speed with minor turbulence at the middle of the room.

750mm Gap





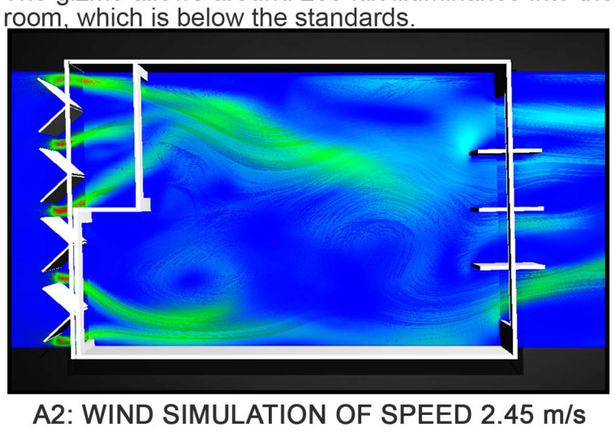



**A2: DAYLIGHT FACTOR SIMULATION**

750mm gap gizmo allows around 2.3% of DF with acceptable glare within 3m from the opening.

**A2: ILLUMINANCE (FLUX) SIMULATION**

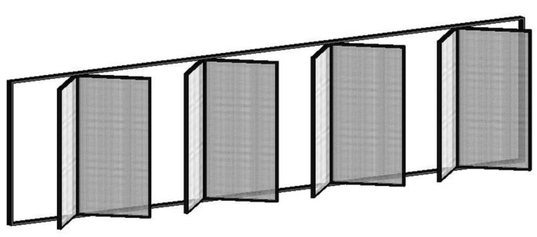
The gizmo allows around 200 lux illuminance into the room, which is below the standards.

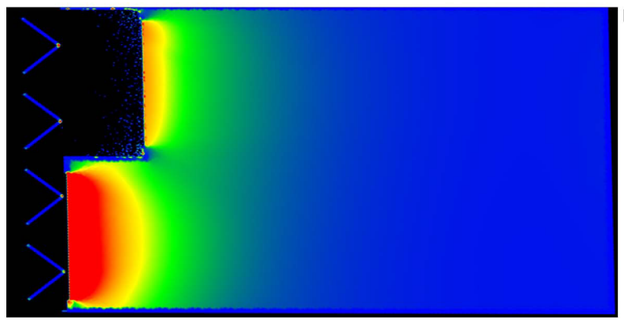


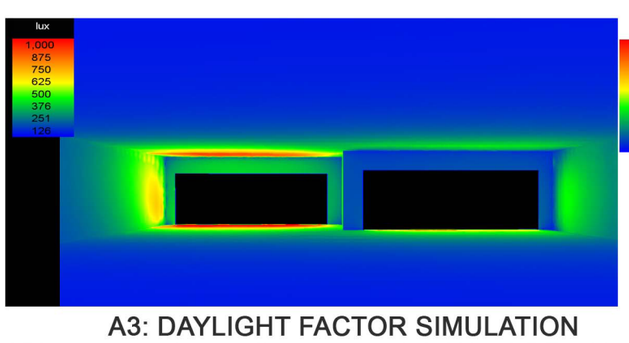
**A2: WIND SIMULATION OF SPEED 2.45 m/s**

Acceptable wind flow and speed, but with more turbulence throughout the room as compared with A1.

950mm Gap





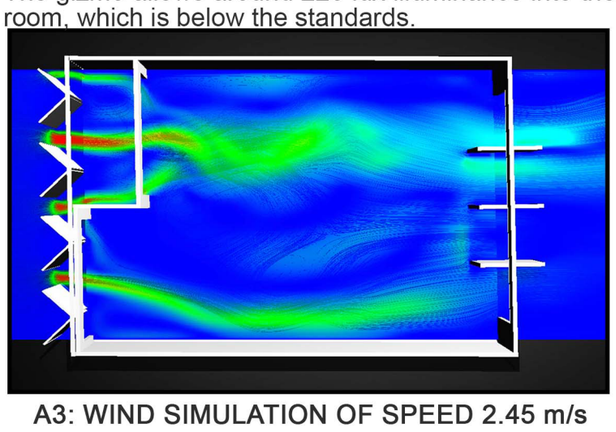



**A3: DAYLIGHT FACTOR SIMULATION**

950mm gap gizmo allows around 2.6% of DF with acceptable glare within 3m from the opening.

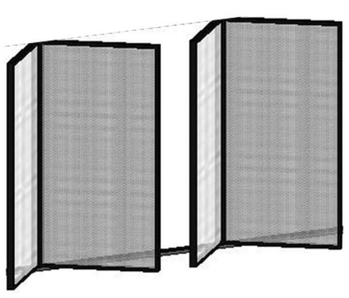
**A3: ILLUMINANCE (FLUX) SIMULATION**

The gizmo allows around 220 lux illuminance into the room, which is below the standards.



**A3: WIND SIMULATION OF SPEED 2.45 m/s**

Extra high wind speed at gizmo results in relatively high wind speed and flow in the room as compared with A1 and A2.






**Daylight simulation analysis**

By comparing the daylight factor simulations of A1, A2 and A3, A1 and A2 have similar DF around 2.3%, whereas A3 has slightly higher DF around 2.6%. The simulations show that DF of all gizmo are within acceptable range based on the standards stated in MS1525:2014.




All three gizmo have similar illuminance around 200-220 lux basesd on the simulations generated from Velux. The illuminance of all three gizmo are slightly lower than the standards.




**Wind Simulation Analysis**

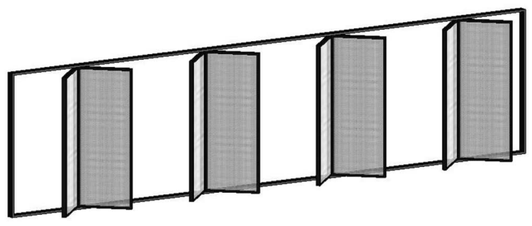
By comparing all the wind simulations, A1 is more preferrable as the wind speed and flow are more acceptable and smooth as compared with A2 and A3. Also, high wind velocity area in A1 is lesser as compared with A2 and A3.

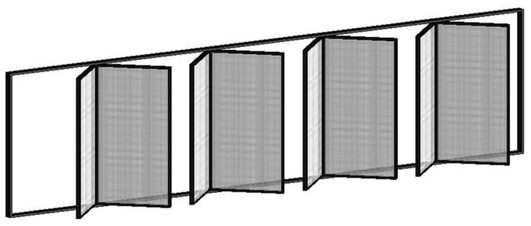
A2 with more wind velocity area results in more turbulence throughout the room than A1. The wind flow of A3 is similar with A2 but the average wind velocity in A3 is the highest among all the simulations.

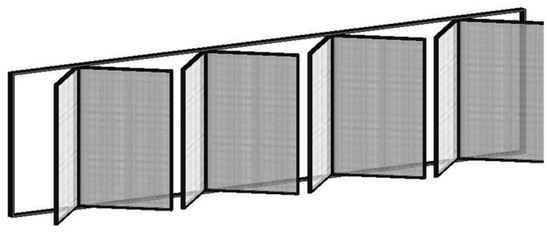
Kurrimbaccus Ally 0340629 Ong Ker Sin 0321719 Tay Jia Jian 0315508 Yang Jing Loo 0323066

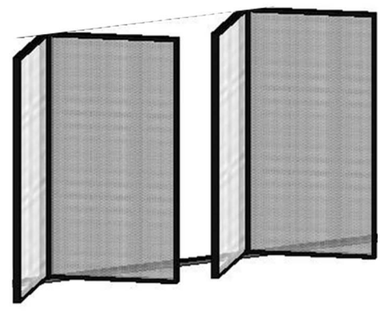
# Gizmo Third Series Simulation (Length Variation)

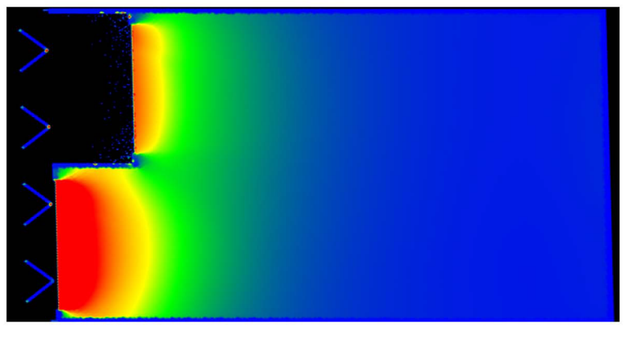
1370mm Length | 1870mm Length | 2370mm Length

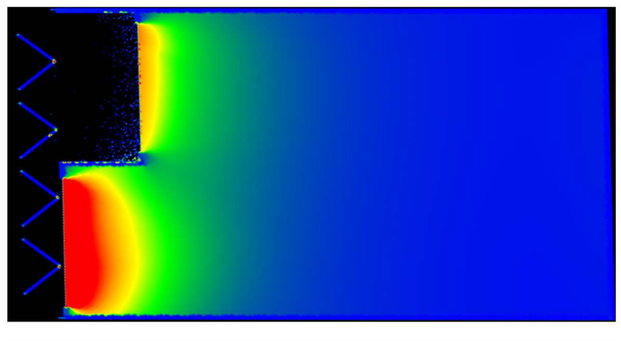


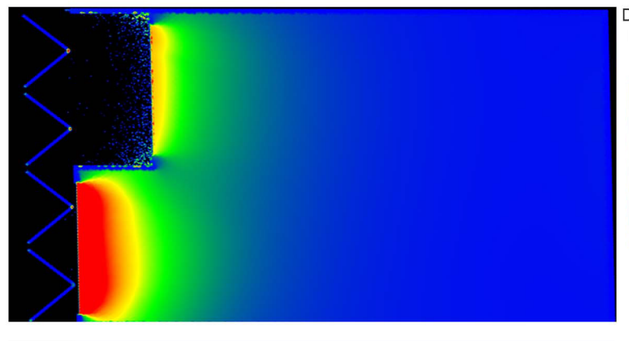


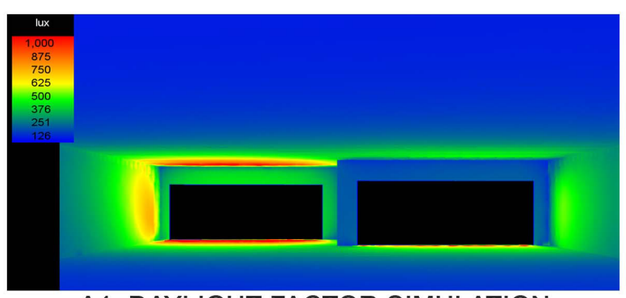


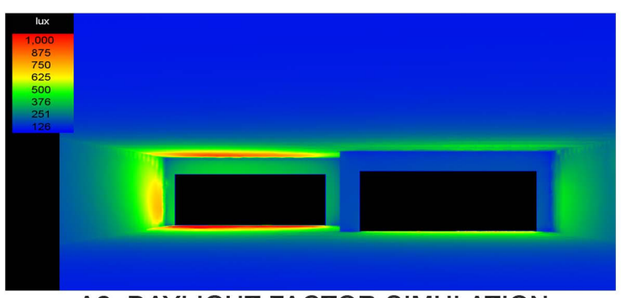


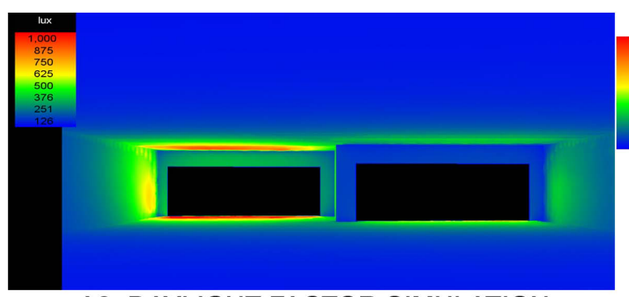









**A1: DAYLIGHT FACTOR SIMULATION**
1370mm length gizmo allows around 2.8% of DF within 3m from the opening.

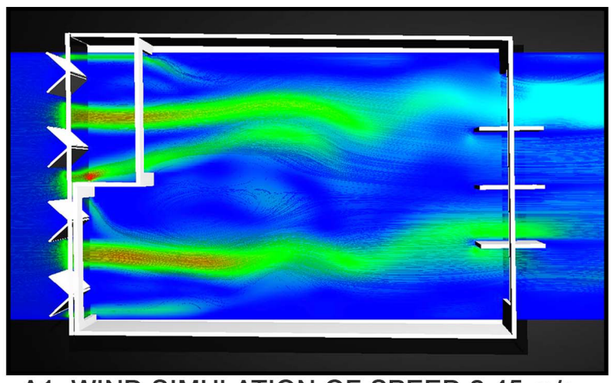
**A1: ILLUMINANCE (FLUX) SIMULATION**
The gizmo allows around 195 lux illuminance into the room, which is below the standards.

**A2: DAYLIGHT FACTOR SIMULATION**
1870 length gizmo allows around 2.2% of DF within 3m from the opening.

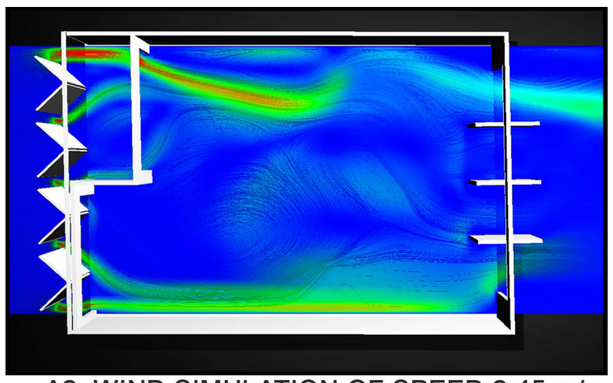
**A2: ILLUMINANCE (FLUX) SIMULATION**
The gizmo allows around 183 lux illuminance into the room, which is below the standards.

**A3: DAYLIGHT FACTOR SIMULATION**
2370 length gizmo allows around 2.0% of DF within 3m from the opening.

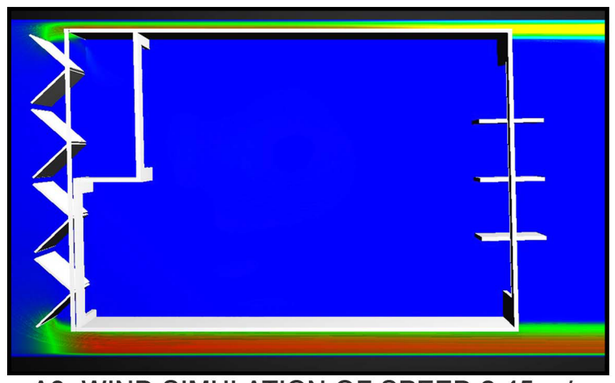
**A3: ILLUMINANCE (FLUX) SIMULATION**
The gizmo allows around 164 lux illuminance into the room, which is below the standards.



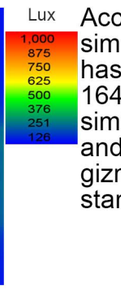
**A1: WIND SIMULATION OF SPEED 2.45 m/s**
High wind speed and flow result in excessive turbulence at the middle of the room.



**A2: WIND SIMULATION OF SPEED 2.45 m/s**
High wind speed and flow at gizmo cause minor turbulence at the middle of the room.



**A3: WIND SIMULATION OF SPEED 2.45 m/s**
2370mm length gizmo has blocked wind flow and cross ventilation into the room.

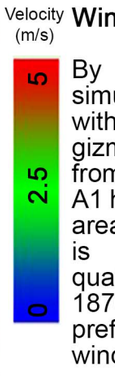



**Daylight Simulation Analysis**

By comparing the daylight factor simulations of A1, A2 and A3, A2 and A3 have similar DF around 2.2% and 2.0% respectively. A1 has the highest DF around 2.8%. The DF of all three gizmo are wihtin acceptable range based on the standards stated in MS1525:2014.



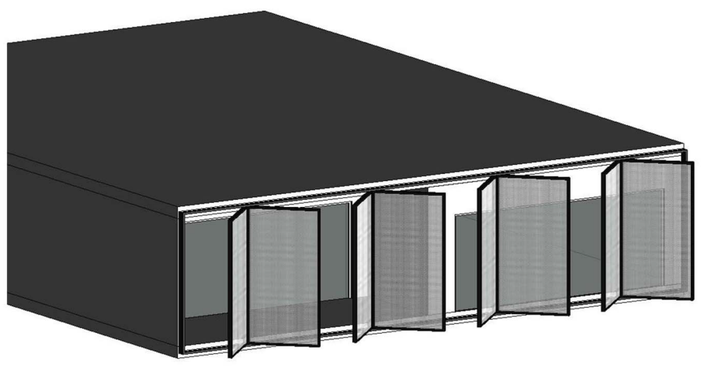

According to the illuminance simulations of A1, A2 and A3, A3 has the lowest illuminance around 164 lux. Whereas, A1 and A2 have similar illuminace around 195 lux and 183 lux respectively. All three gizmo have illuminance below the standards.



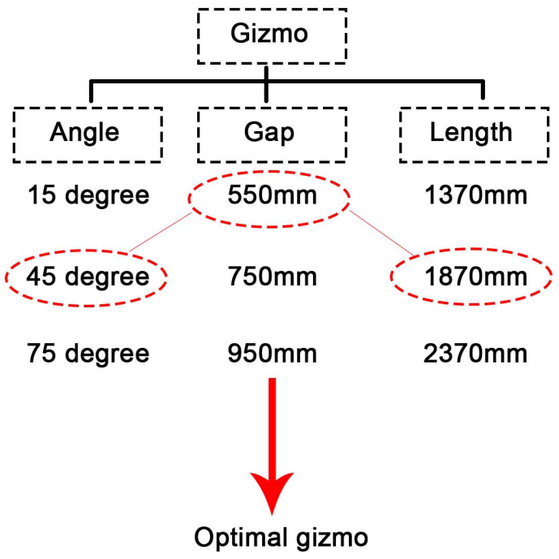

**Wind Simulation Analysis**

By comparing all the wind simulations, A3 is at the extreme with no wind flow in the room as the gizmo has blocked the natural wind from entering the room. Whereas, A1 has excessive high wind velocity area that causes turbulence which is unacceptable for indoor air quality. Therefore, A2 simulation of 1870mm length gizmo is the preferrable length with acceptable wind speed and flow in the room.

# Optimized Gizmo



Optimal gizmo design

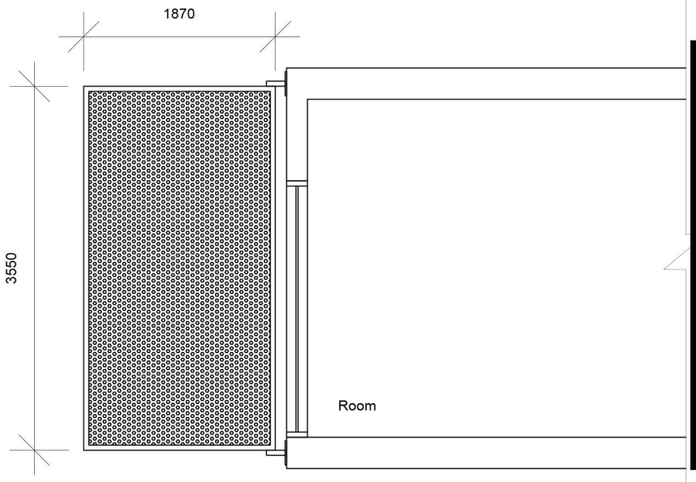



Based on the the daylight factor and wind simulations generated from Velux and Flow Design respectively, the optimal design of gizmo we have concluded consists of perforated aluminium facade with a combination of 45 degree angle, 550mm gap and 1870 length. The results of optimal gizmo are summarized as below:

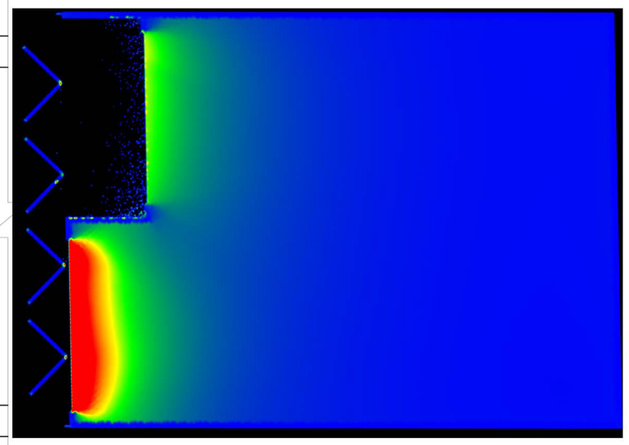
**1) Daylight factor simulation**
According to the daylight factor simulation of optimal gizmo, the DF is around 1.5% within 3m from the opening, which is within acceptable range in terms of lighting, glare and thermal comfort based on MS1525:2014.

**2) Illuminance simulation**
The average illuminance of optimal gizmo is around 136 lux with around 300 lux within 3m from the opening. The results show that the glare and lighting at the space within 3m from the opening is within acceptable range.

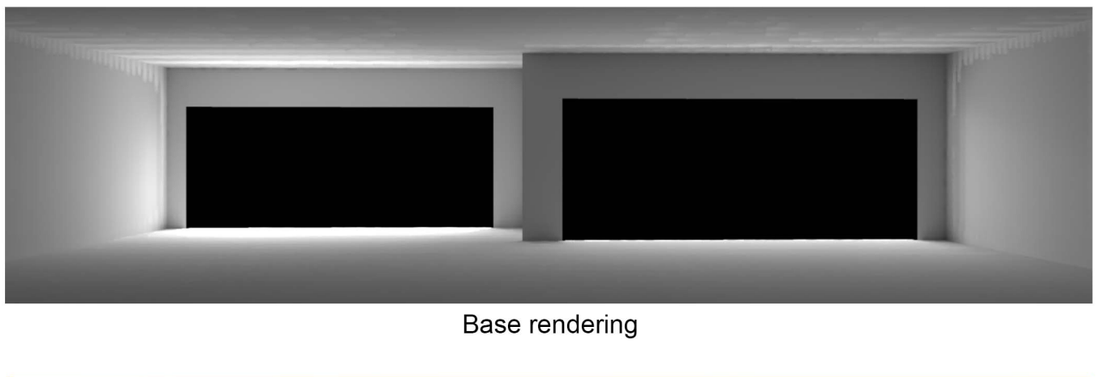
**3) Wind simulation**
The wind simulation of optimal gizmo shows an acceptable wind speed and flow occur through the room. There is no turbulence as observed from the previous simulations of baseline model and the series of simulations (angle, gap and length).



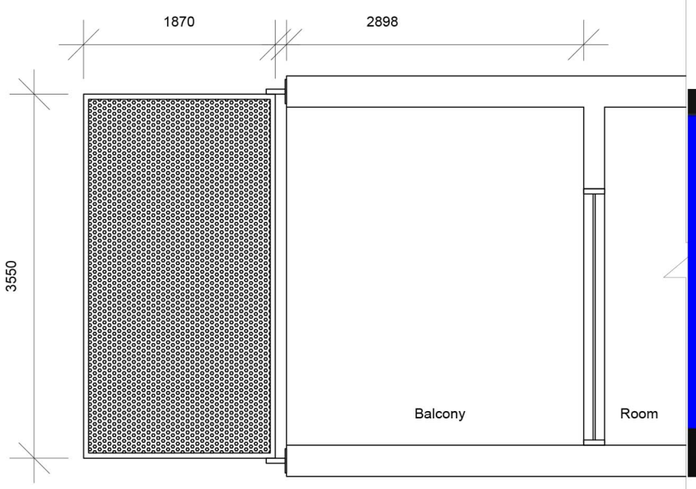

Gizmo detail of room



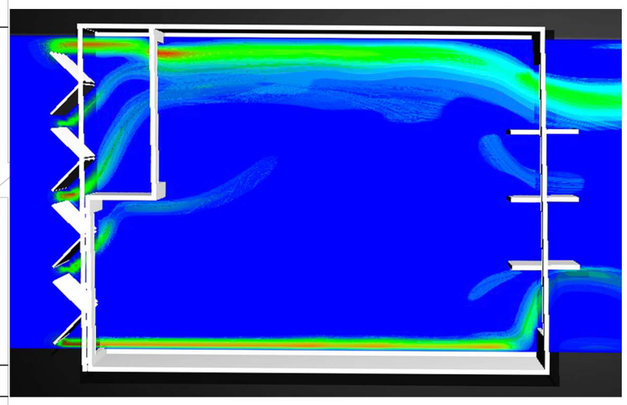
Plan view of daylight factor simulation



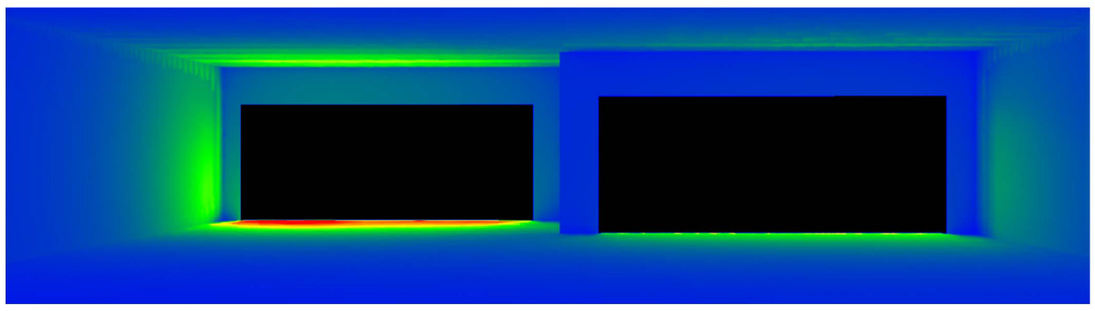
Base rendering



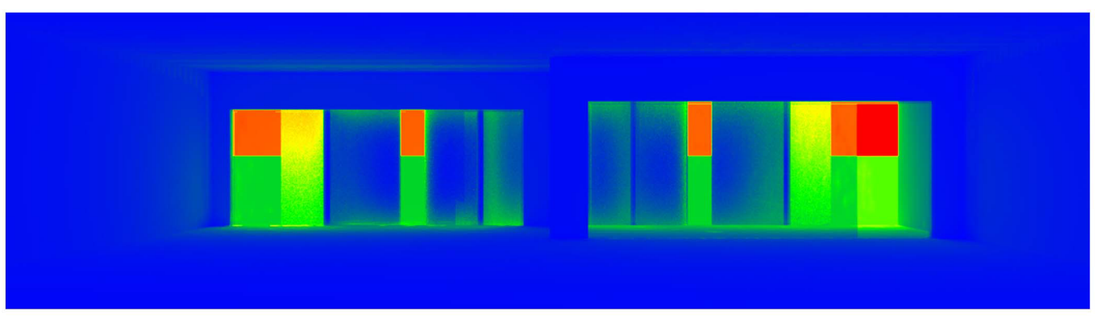

Gizmo detail of room with balcony



Wind simulation of speed 2.45 m/s



Illuminance rendering



Luminance rendering