



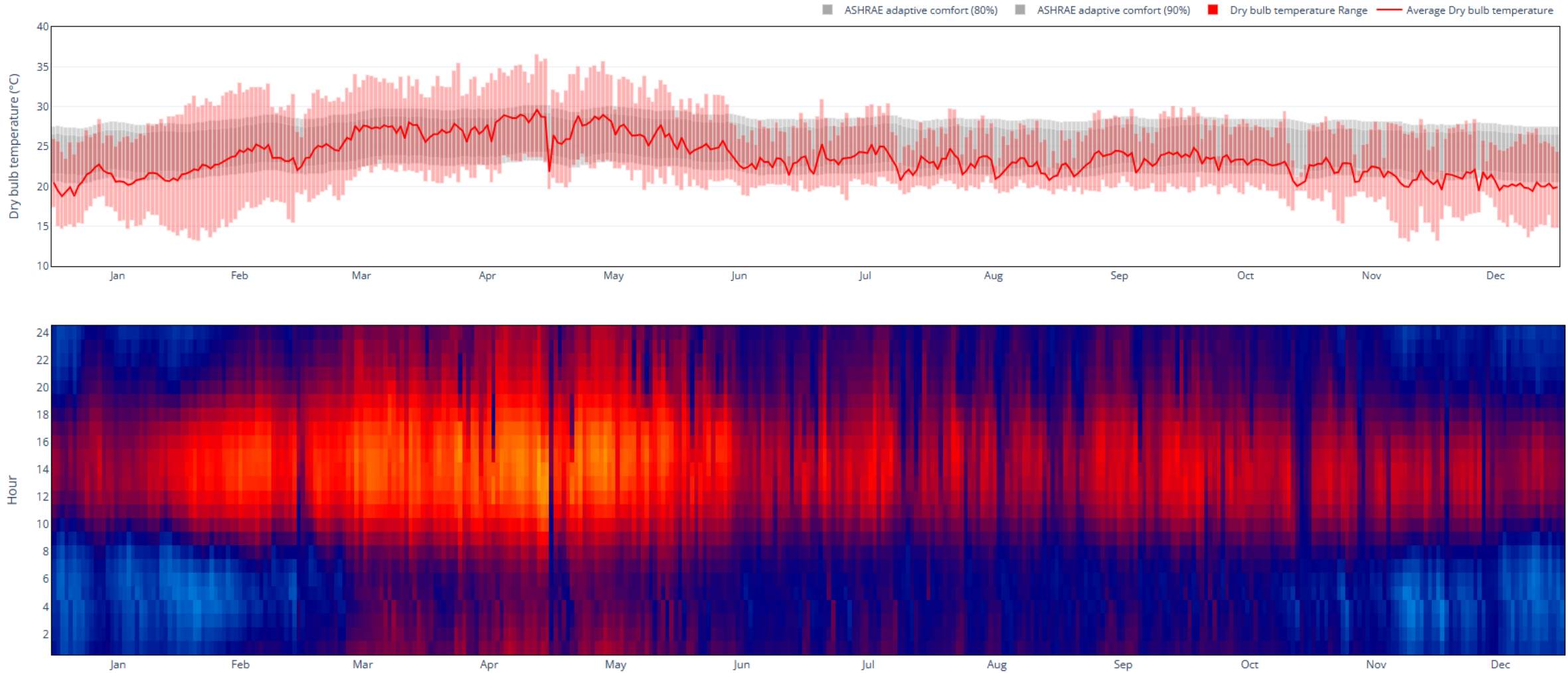
National Law School of India University

Bangalore

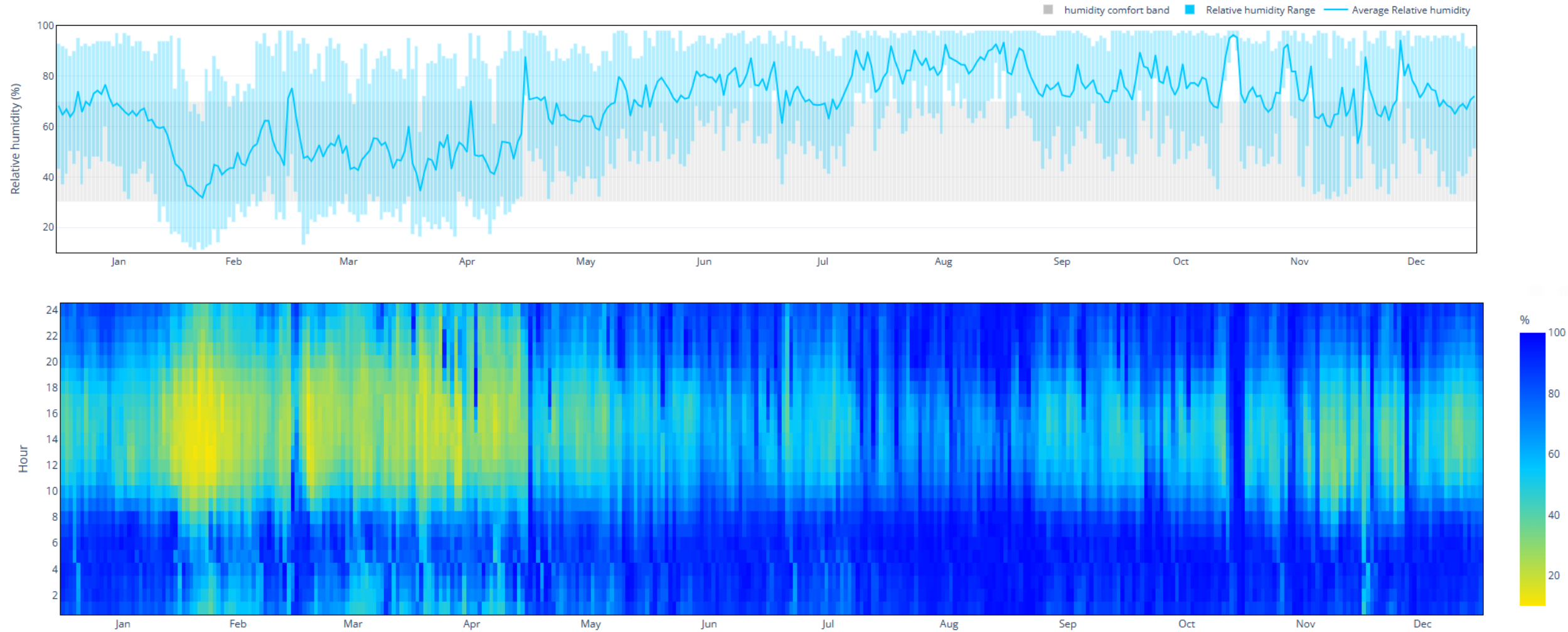
Sustainability Analysis Report

DCOOP

 **McD BERL**

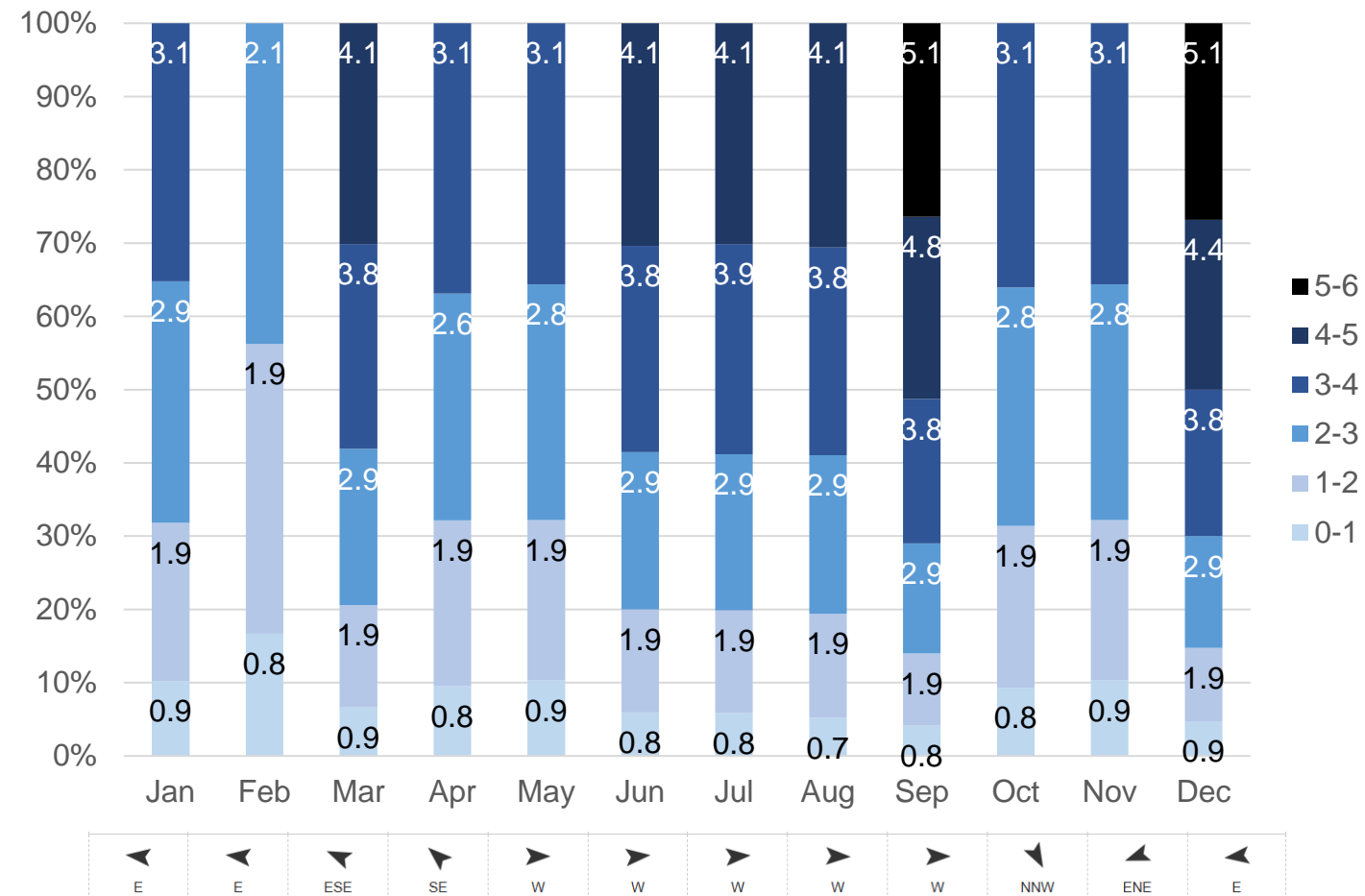


Dry bulb temperatures soar up to a maximum of 36.6°C in the month of April. Lowest recorded temperature is 13°C in the early mornings of November month. The diurnal temperature difference between day-time and night-time ranges between 10°C to 15°C. Cooling to lower temperatures during the summer daytime hours and some hours of night are also essential to ensure comfort for occupants.

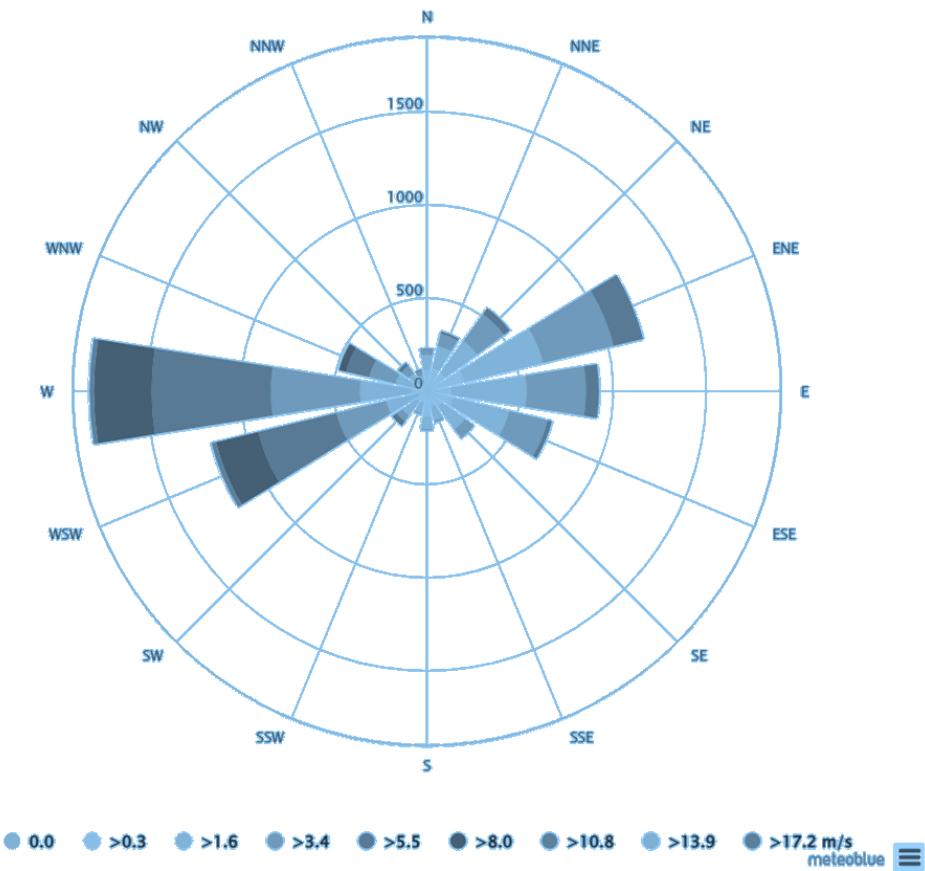


The relative humidity is low only in the summer months. Monsoon months have high humidity > 70 %.

Natural ventilation during these months will be helpful.

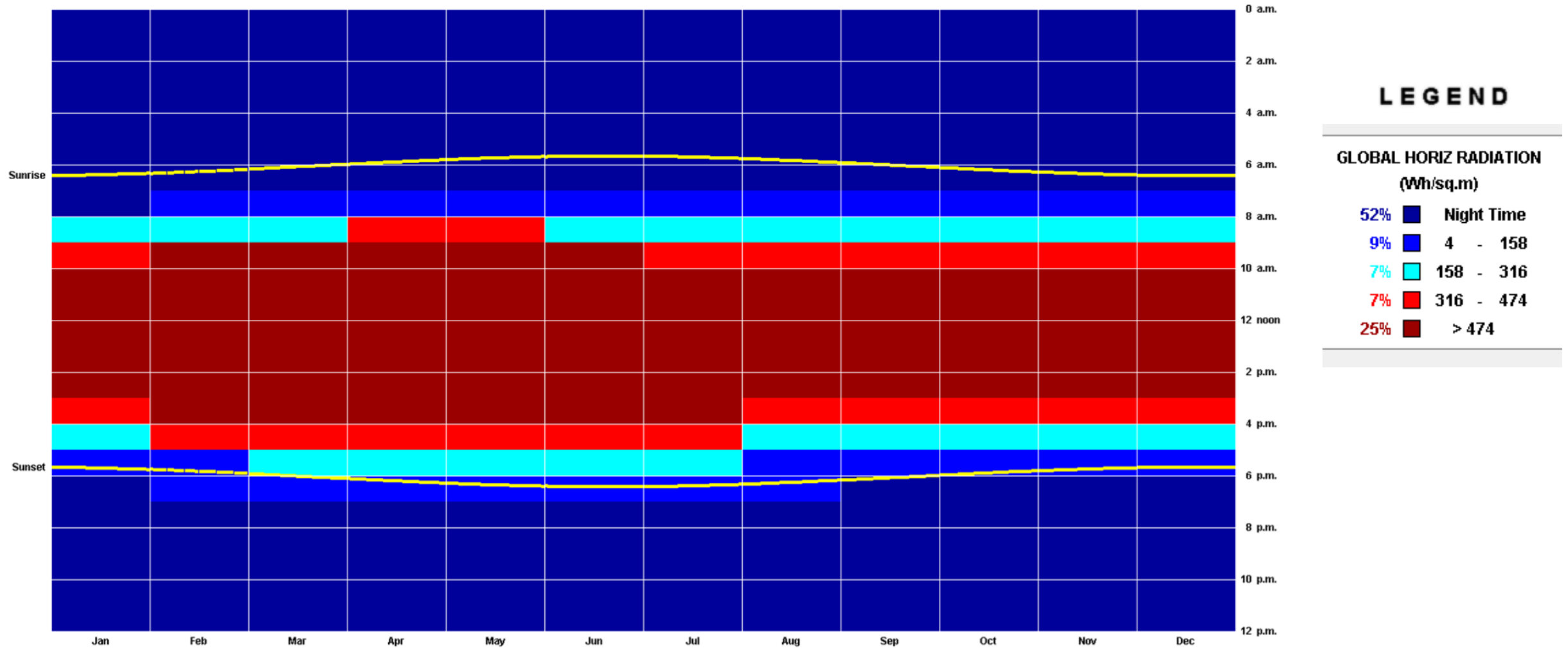


Monthly Wind Speed Data Analysis



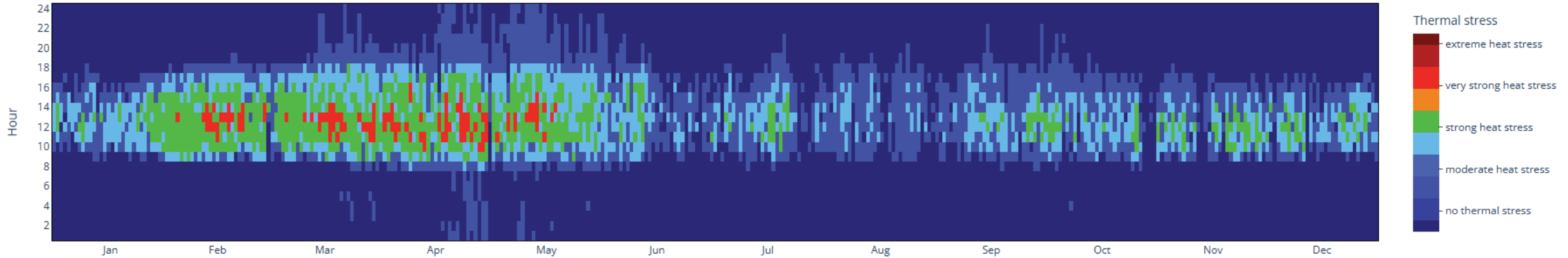
Wind Rose

The wind data has been analyzed for each month, in terms of speed and direction. Based on analysis, the inputs have been taken into the simulation. West wind has been considered for the month of May, with a wind speed of 4 m/s. Winter wind from East in the month of January with a speed of 4 m/s and Monsoon wind from South-West in September has been taken for Computational Fluid Dynamics Simulation of External Wind behavior.

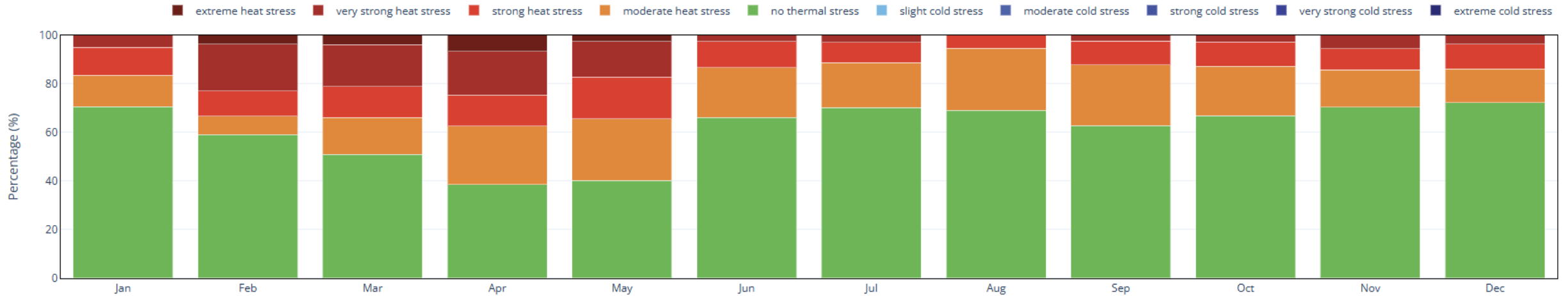


25% of hours during the day have global horizontal radiation levels above 474 Wh/ sq.m. The upper limit for radiation levels prescribed by the ASHRAE 55 Standard is 316 Wh/ sq.m. 31 % of hours experience radiation levels beyond this limit. This needs to be addressed by adequate shading.

UTCI thermal stress



UTCI thermal stress distribution



Summer months experience strong heat stress when temperatures cross 32°C and very strong heat stress during day-time hours between 8 am to 18 pm, when temperatures soar above 38°C.

To alleviate thermal stress and achieve comfort, the temperature needs to be reduced to 26°C.



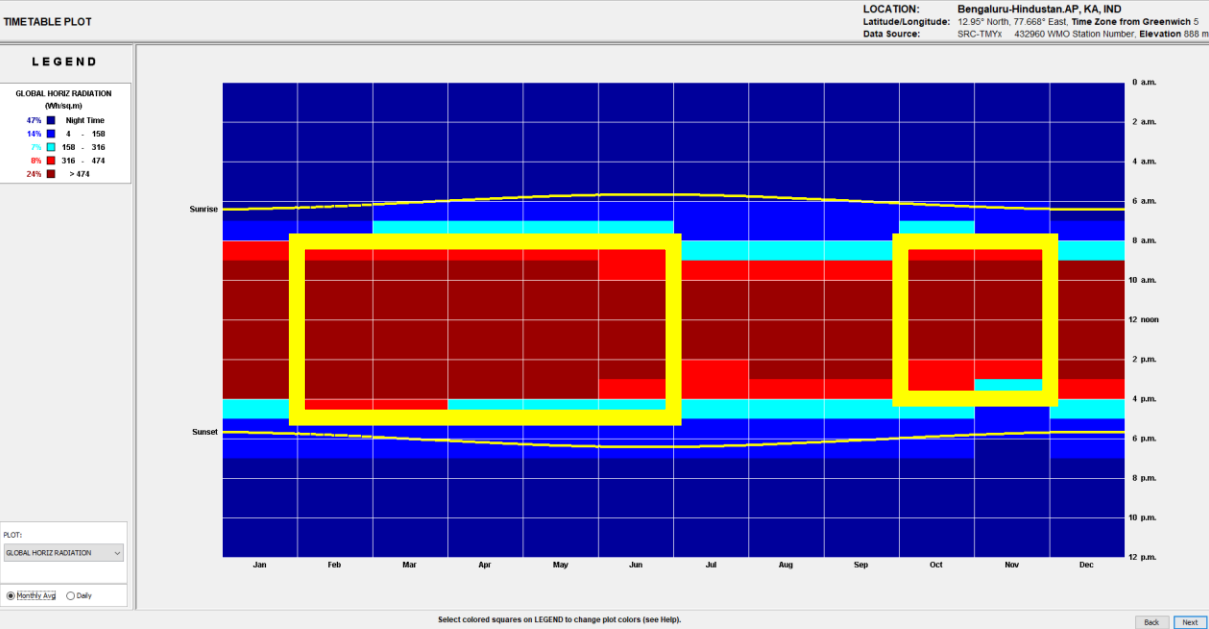
CLIMATE ANALYSIS

Considerations

Global Horizontal Radiations Chart

25% of hours during the day have global horizontal radiation levels above 474 Wh/ sq.m. The upper limit for radiation levels prescribed by the ASHRAE 55 Standard is 316 Wh/ sq.m. 31 % of hours experience radiation levels beyond this limit. This needs to be addressed by shading.

The critical months observed from February and March (8.00 AM – 17.00 pm), April to June (8.00AM to 16.00PM) and October to November (8.00 AM – 16.00 pm) with radiations 316 Wh/sq.m and above.



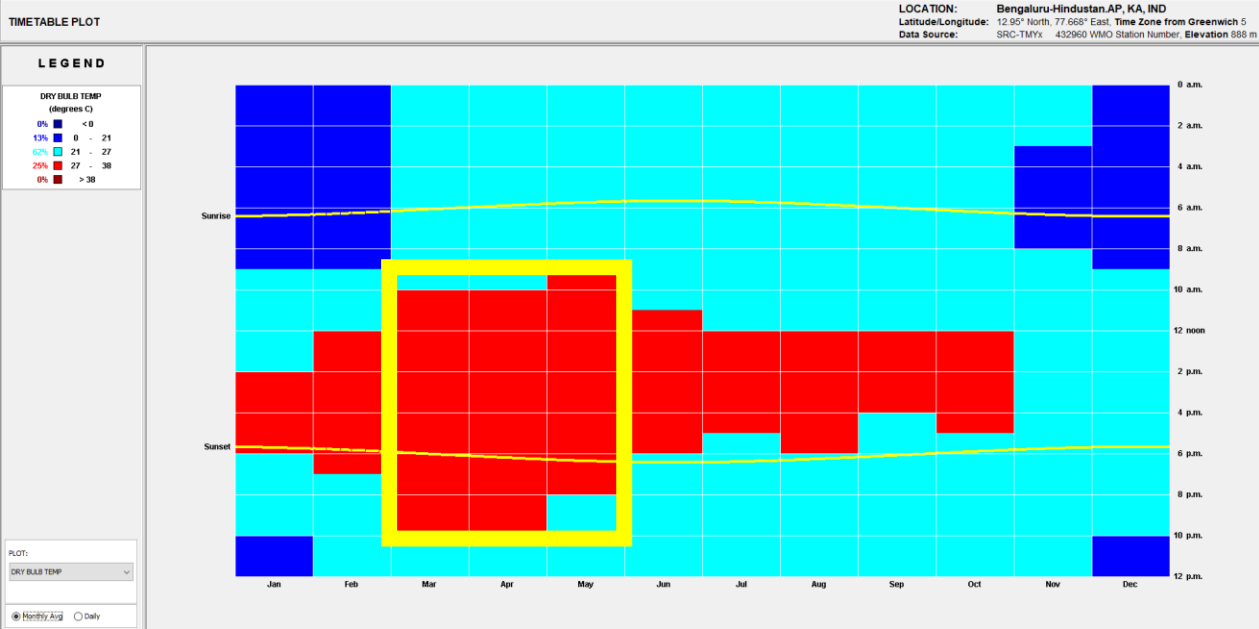
Source: Climate consultant

The critical time considered are March, June and October (from 9.00AM to 4.00PM).

Annual DBT (month wise) Chart

25% of hours during the day have DBT between 27°C - 38°C. The upper limit for radiation levels prescribed by the ASHRAE 55 Standard is 27°C.

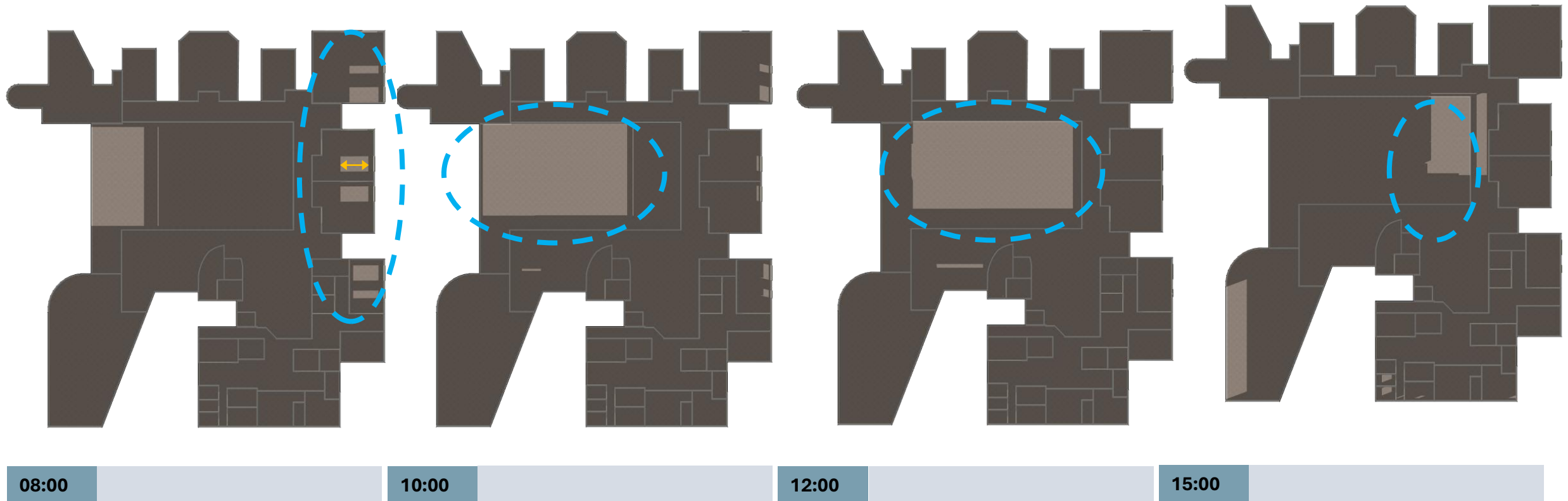
The critical months observed from March to May (from 9.00AM to 10PM)with uncomfortable temperature between 27° to 38°.



Base Case

Solar Ingress Analysis – March 21st

Ground floor



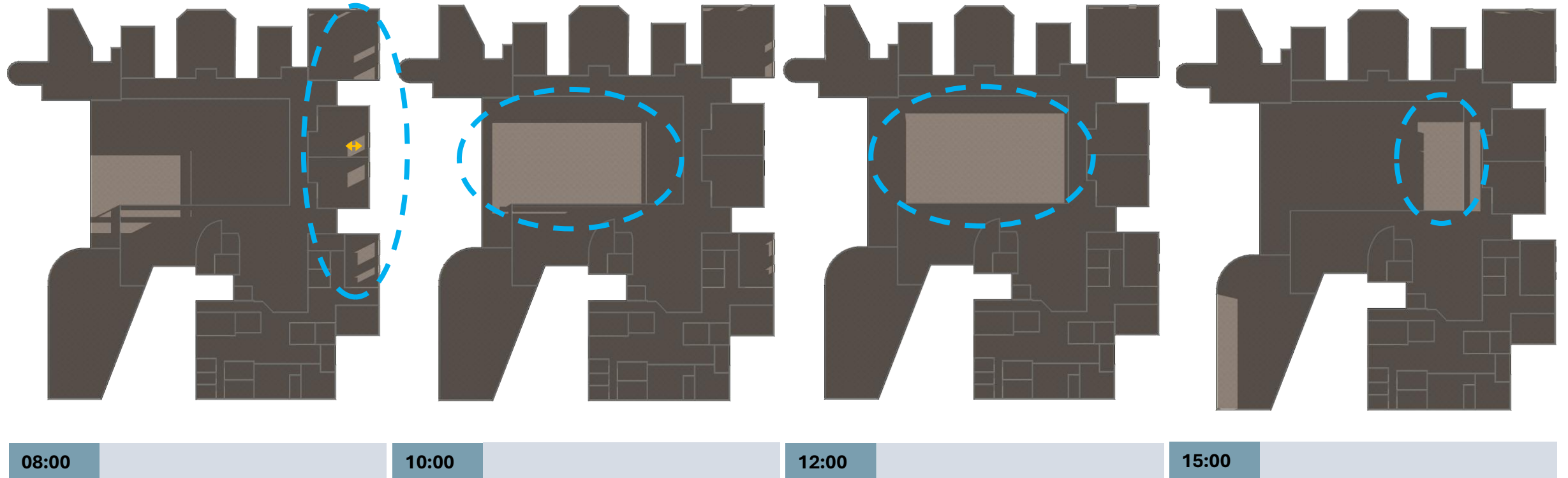
Observation:

- The Classroom, Moot Courts and the Conference Room (eastern windows) receive sunlight between 7 am to 10 am.
- The courtyard receives direct sunlight from 9 am to 6 pm.

Base Case

Solar Ingress Analysis – June 21st

Ground floor



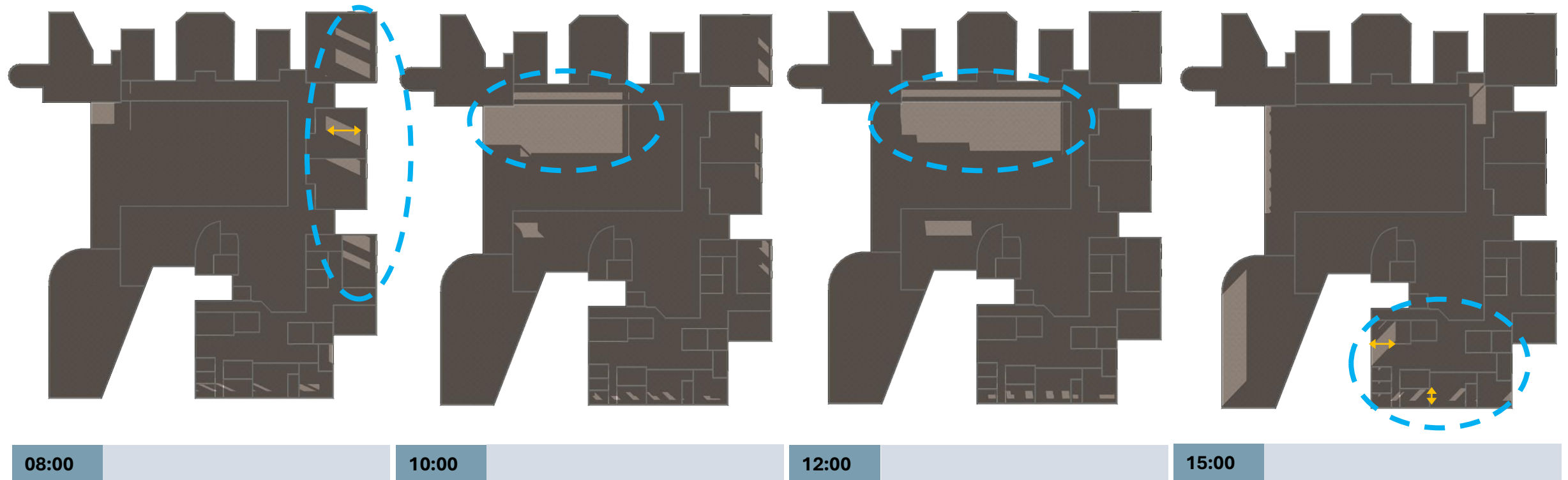
Observation:

- The Classroom, Moot Courts and the Conference Room (eastern windows) receive sunlight between 7 am to 9 am.
- The courtyard receives direct sunlight from 8 am to 6 pm.

Base Case

Solar Ingress Analysis – December 21st

Ground floor



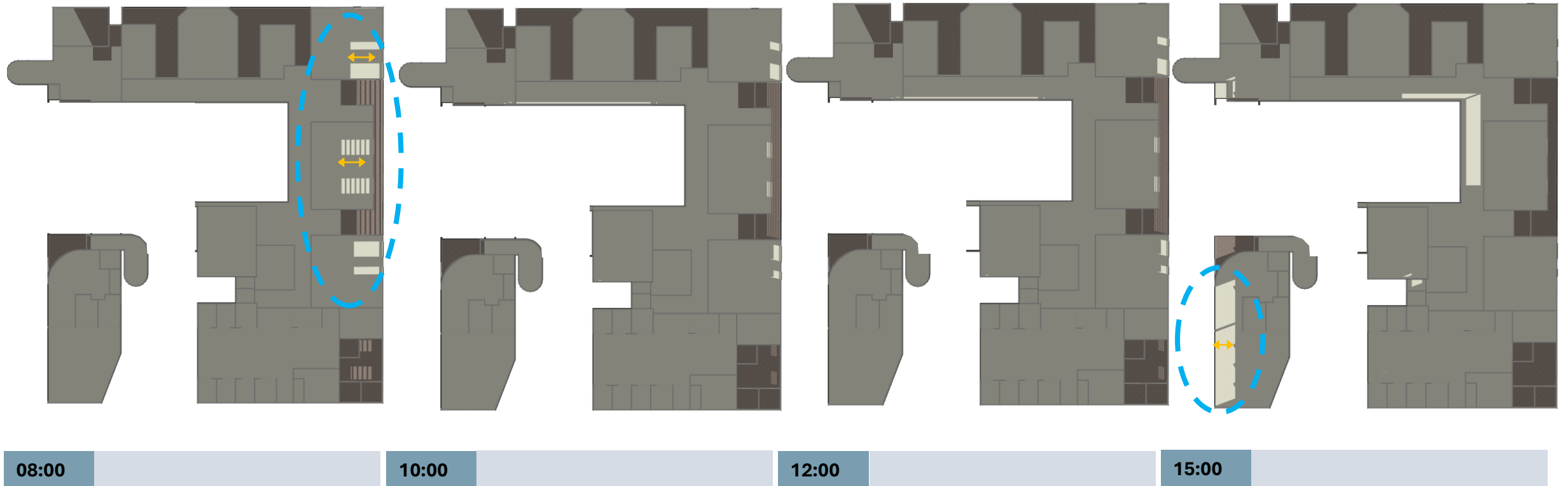
Observation:

- The Classroom, Moot Courts and the Conference Room (eastern windows) receive sunlight between 7 am to 10 am.
- The Admin Area (southern windows) receives some glare between 1 pm to 4 pm.
- The courtyard receives direct sunlight from 9 am to 5 pm.

Base Case

Solar Ingress Analysis – March 21st

First floor



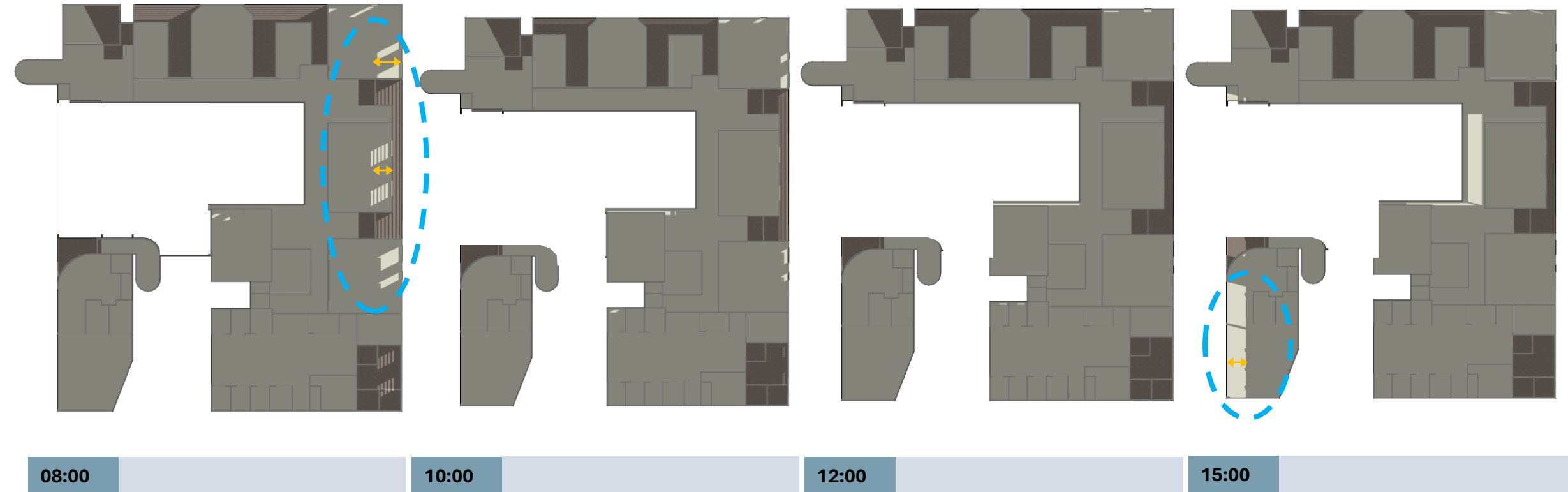
Observation:

- The Classrooms (eastern windows) receive sunlight between 7 am and 10 am. The fins help in glare reduction.
- The Campus Life (western windows) receives glare from 1 pm to 6 pm.

Base Case

Solar Ingress Analysis – June 21st

First floor



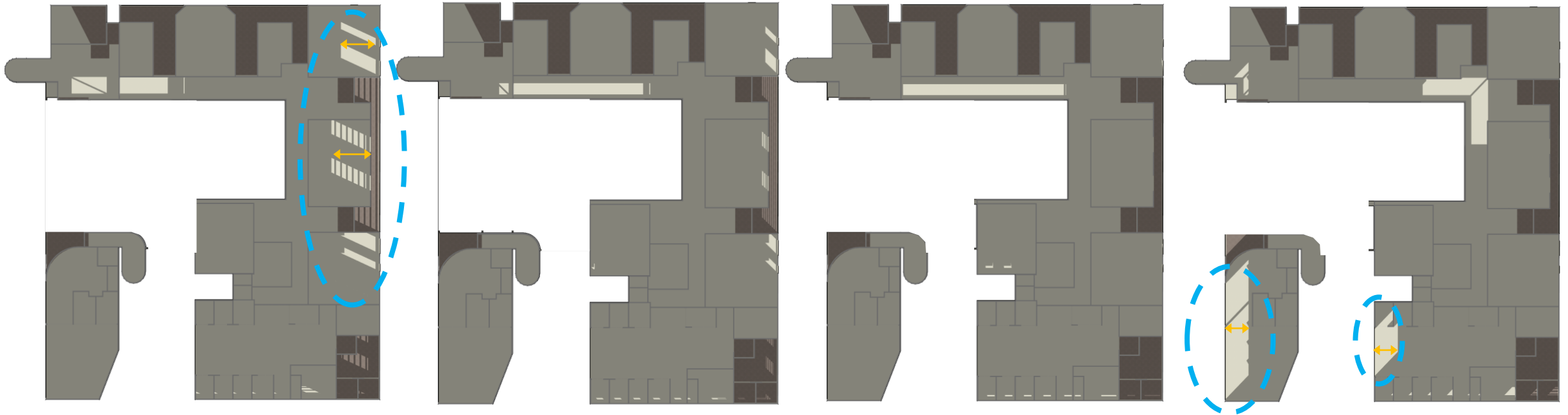
Observation:

- The Classrooms (eastern windows) receive sunlight between 6 am and 9 am. The fins help in glare reduction.
- The Campus Life (western windows) receives glare from 1 pm to 6 pm.

Base Case

Solar Ingress Analysis – December 21st

First floor



08:00

10:00

12:00

15:00

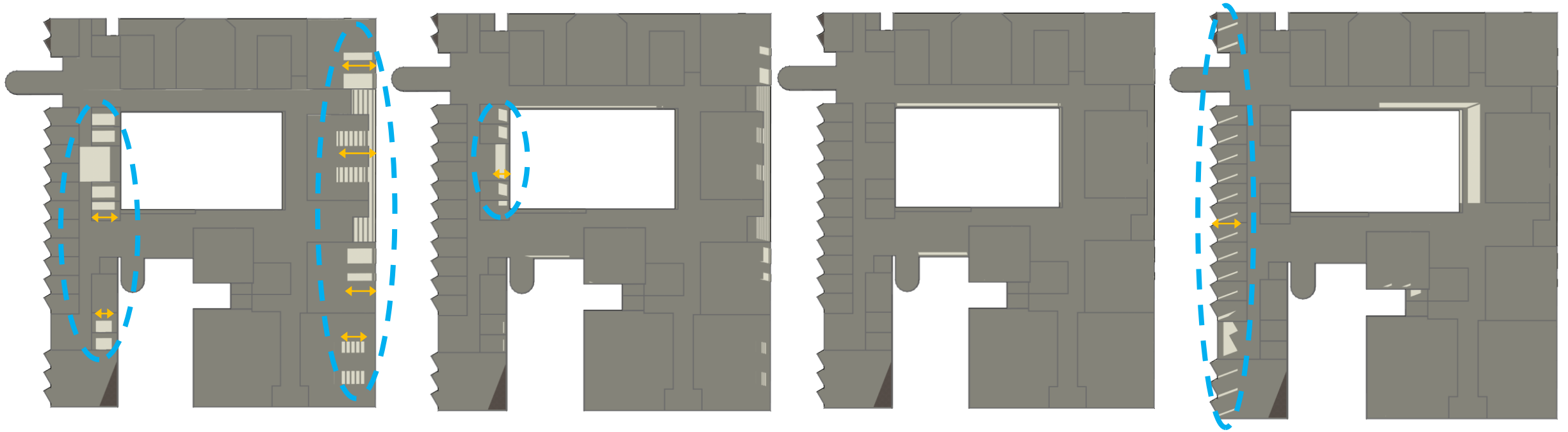
Observation:

- The Classrooms (eastern windows) receive sunlight between 7 am and 10 am. The fins help in glare reduction.
- The Campus Life and the Admin area (western windows) receives glare from 1 pm to 5 pm.

Base Case

Solar Ingress Analysis – March 21st

Second floor



08:00

10:00

12:00

15:00

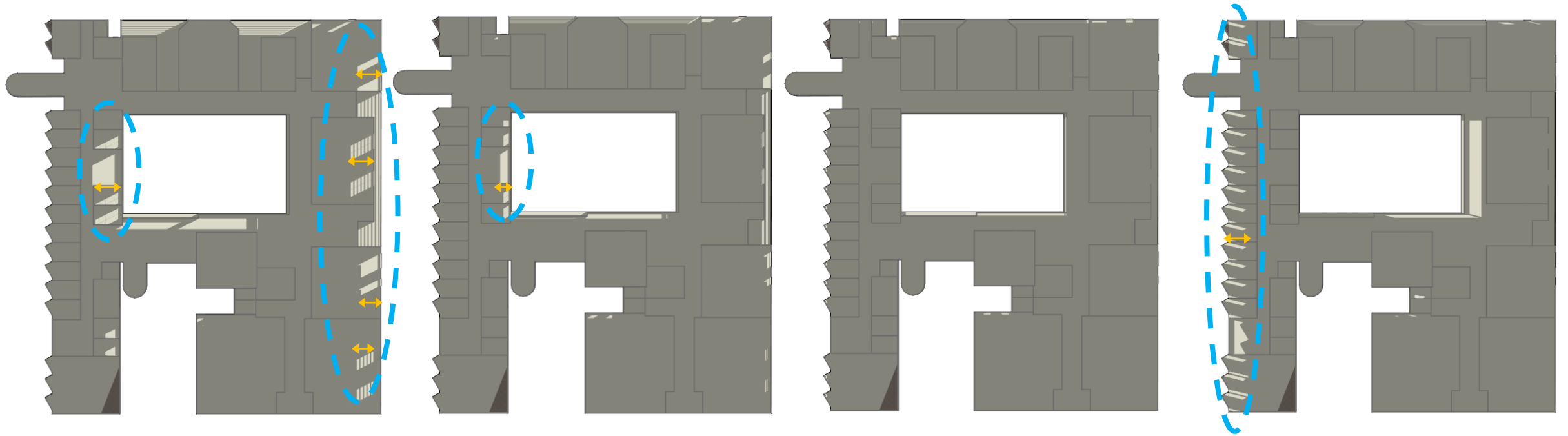
Observation:

- The Classrooms and the a few Faculty Cabins (eastern windows) receive sunlight between 7 am and 10 am. The fins help in glare reduction.
- The Faculty Cabins (western windows) receive glare from 2 pm to 6 pm.

Base Case

Solar Ingress Analysis – June 21st

Second floor



08:00

10:00

12:00

15:00

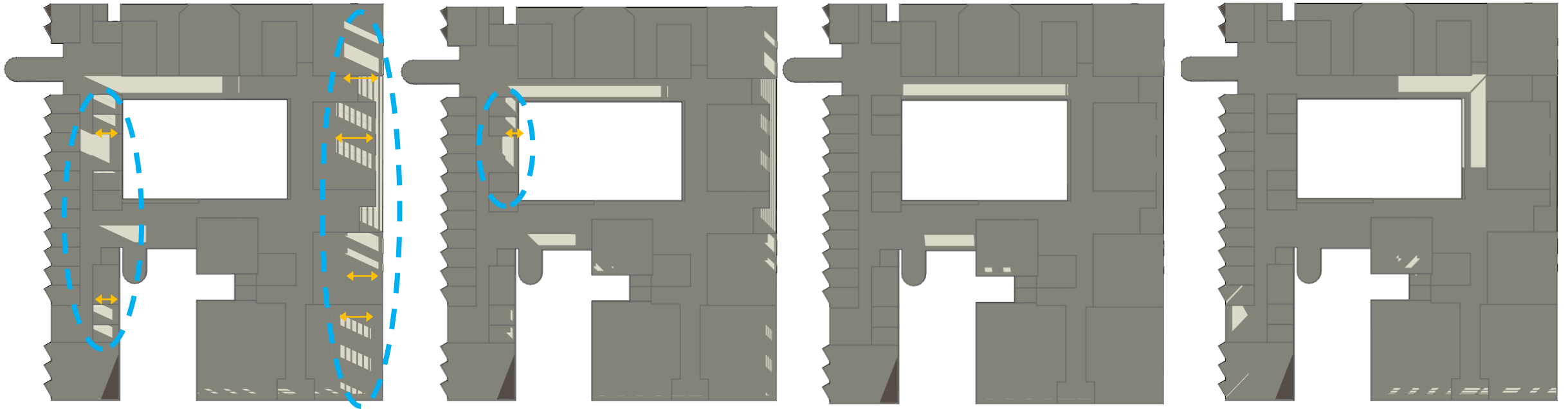
Observation:

- The Classrooms and the a few Faculty Cabins (eastern windows) receive sunlight between 6 am and 10 am. The fins help in glare reduction.
- The Faculty Cabins (western windows) receive glare from 1 pm to 6 pm.

Base Case

Solar Ingress Analysis – December 21st

Second floor



08:00

10:00

12:00

15:00

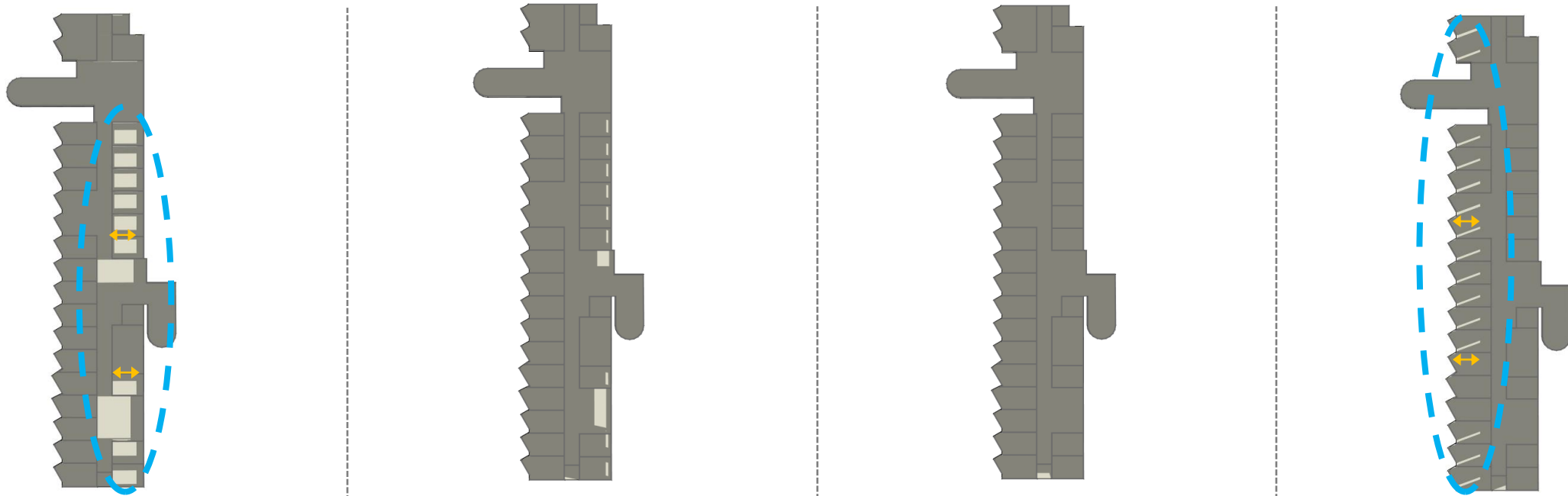
Observation:

- The Classrooms and the a few Faculty Cabins (eastern windows) receive sunlight between 7 am and 10 am. The fins help in glare reduction.

Base Case

Solar Ingress Analysis – March 21st

Typical floor (Third, Fourth and Fifth Floor)



08:00

10:00

12:00

15:00

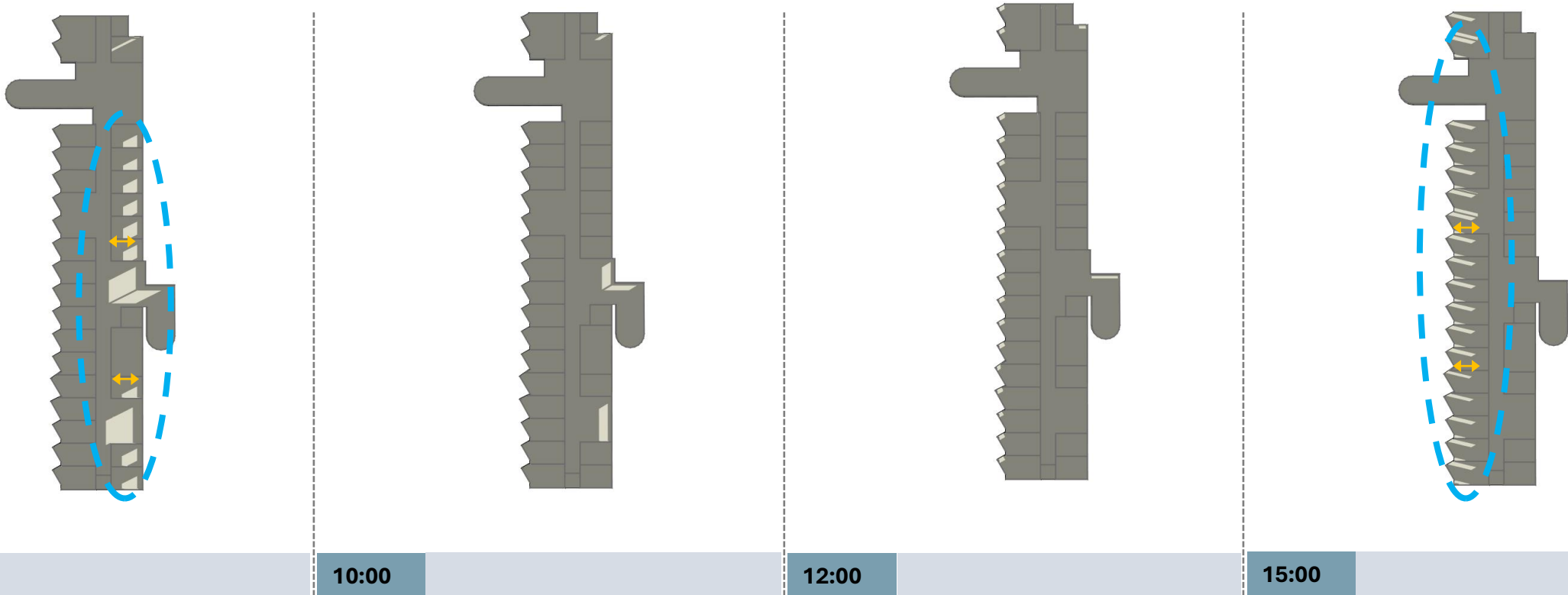
Observation:

- The Faculty Cabins (eastern windows) receive sunlight between 7 am and 10 am.
- The Faculty Cabins (western windows) receive glare between 2 pm to 6 pm.

Base Case

Solar Ingress Analysis – June 21st

Typical floor (Third, Fourth and Fifth Floor)



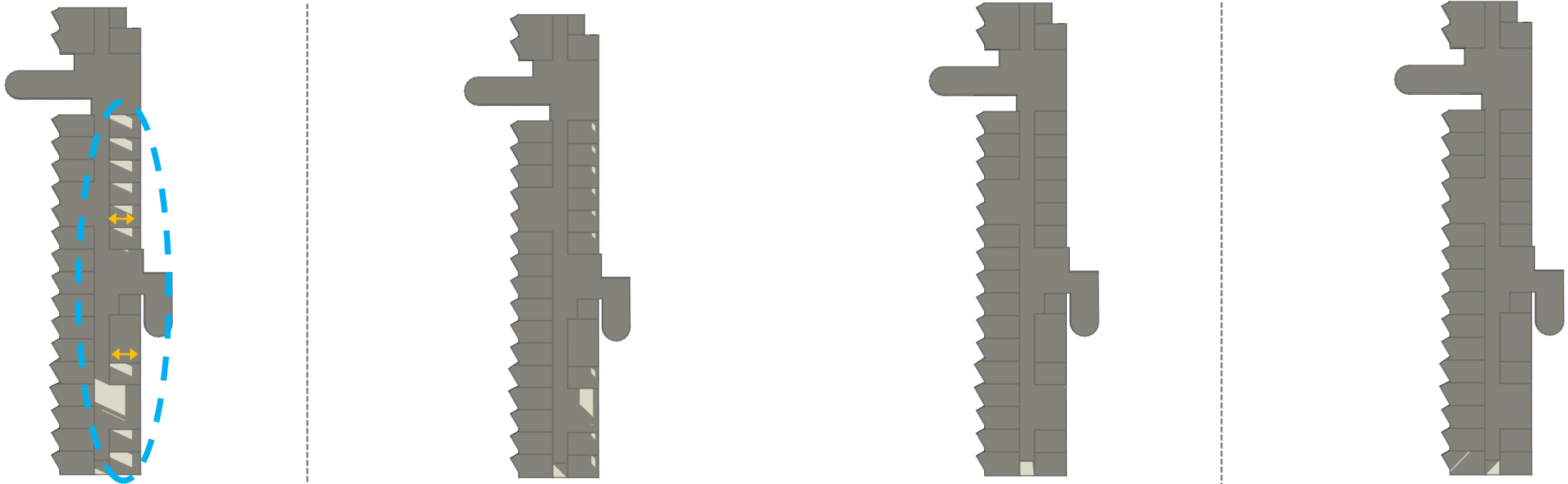
Observation:

- The Faculty Cabins (eastern windows) receive sunlight between 7 am and 9 am.
- The Faculty Cabins (western windows) receive glare between 1 pm to 6 pm.

Base Case

Solar Ingress Analysis – December 21st

Typical floor (Third, Fourth and Fifth Floor)



08:00

10:00

12:00

15:00

Observation:

- The Faculty Cabins (eastern windows) receive sunlight between 7 am and 9 am.

Base Case

Software

Daylight analysis has been performed on Radiance. Building has been modeled in Design Builder based on architectural drawings from design team.
Daylight Illuminance analysis has been performed at sun sky 21st September at 12:00. Outside lux has been taken from EPW weather file of Bengaluru.

Simulation Assumptions / Consideration

Properties of material reflectance had been assumed to perform daylight analysis. These are as follows:

Sl. No.	Category	Specifications
1	Analysis Floor	Ground floor at 750 mm
2	Wall Reflection	50%
3	Ceiling Reflection	70%
4	Floor Reflection	30%
5	Glass VLT	67%
6	External Shading	As per design



Base Case

PTI : September 21, 12 PM

Ground floor

Sl. No.	Illuminance levels (lux)	Percentage Area (%)
1	< 110	43.53
2	110 - 2200	56.32
3	300 - 3000	31.25

- There is lack of daylight on the ground floor. The moot courts and admin areas need improved daylight.
- Suitable daylight strategies need to be worked out.



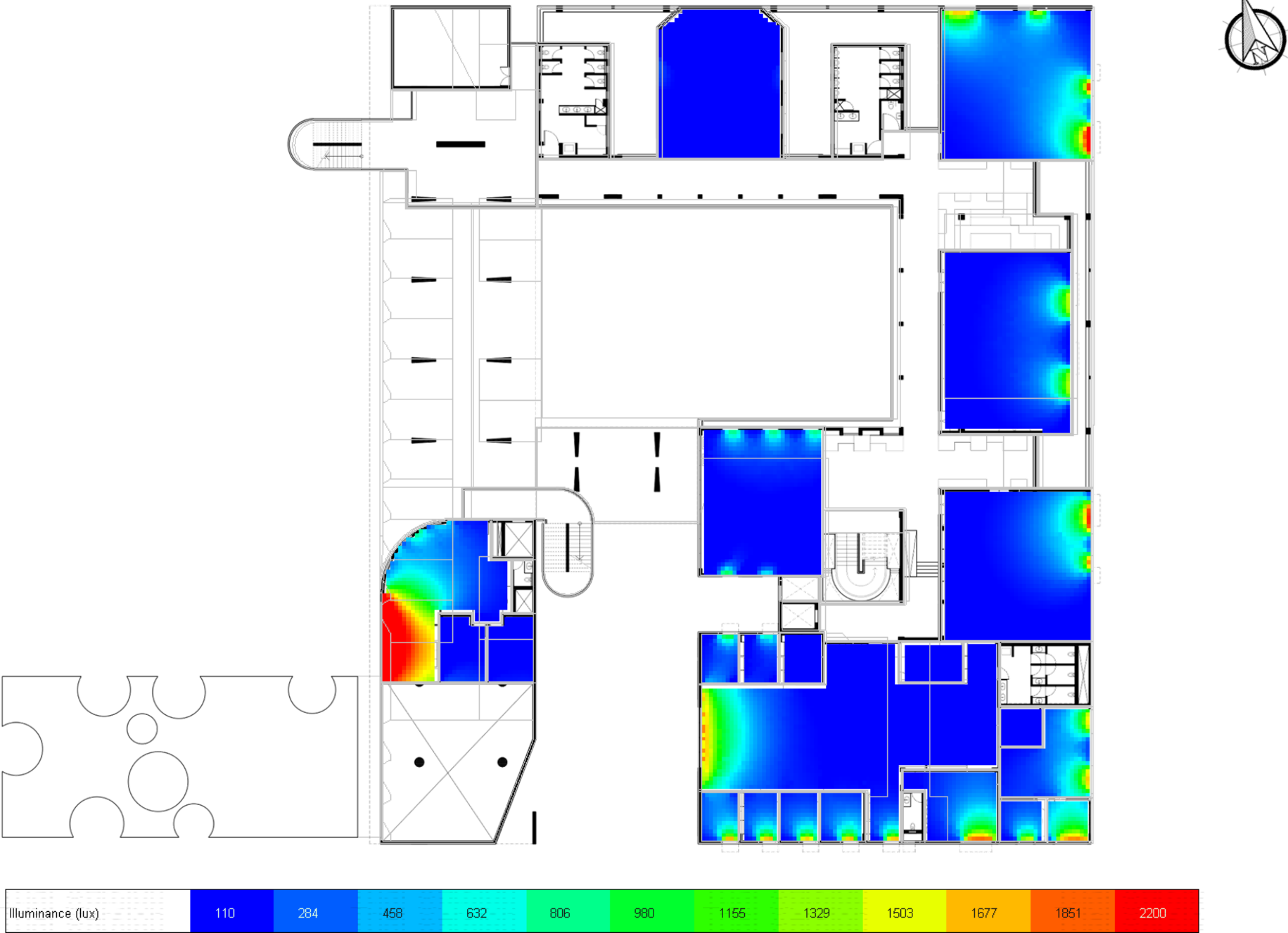
Base Case

PTI : September 21, 12 PM

First floor

Sl. No.	Illuminance levels (lux)	Percentage Area (%)
1	< 110	40.14
2	110 - 2200	58.88
3	300 - 3000	30.46

- There is lack of daylight on the first floor. Daylight levels in the classrooms need to be improved.
- Suitable daylight strategies need to be worked out.

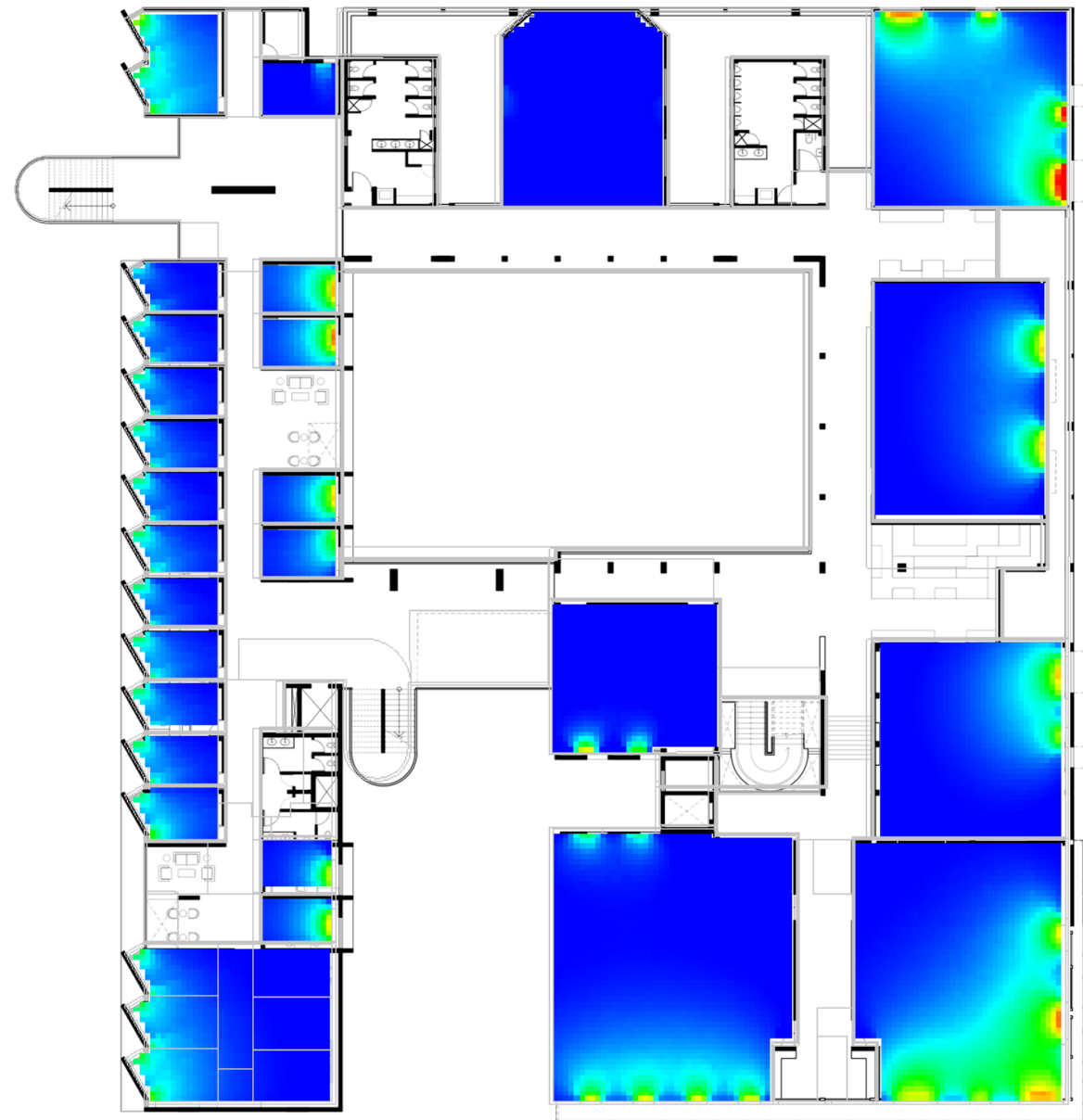


Second floor

- The second floor has slightly better daylight levels.

However, improvement is required in the southern and eastern classrooms.

- Suitable daylight strategies need to be worked out.





Base Case

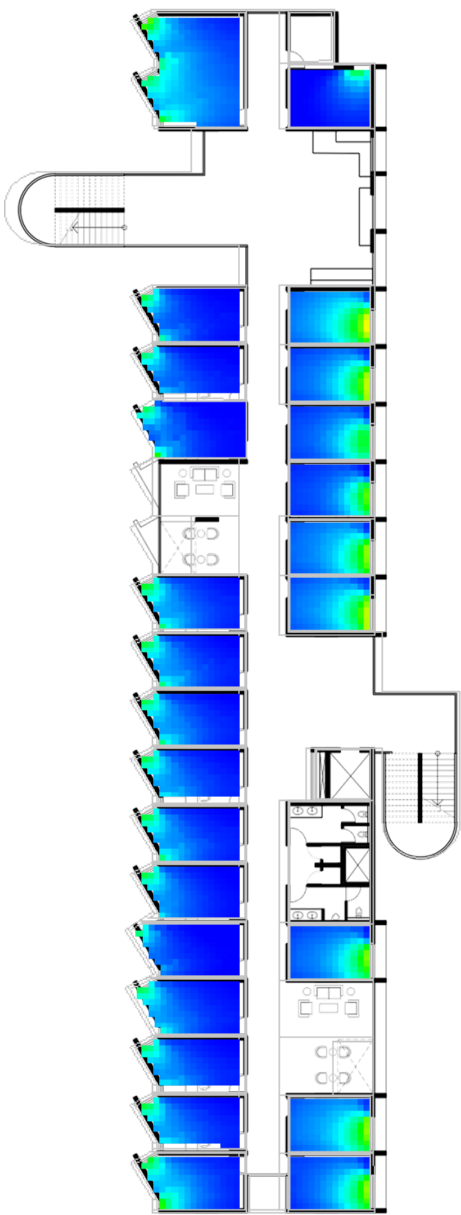
PTI : September 21, 12 PM

Typical floor (Third, Fourth and Fifth Floor)

Sl. No.	Illuminance levels (lux)	Percentage Area (%)
1	< 110	3.68
2	110 - 2200	96.31
3	300 - 3000	53.20

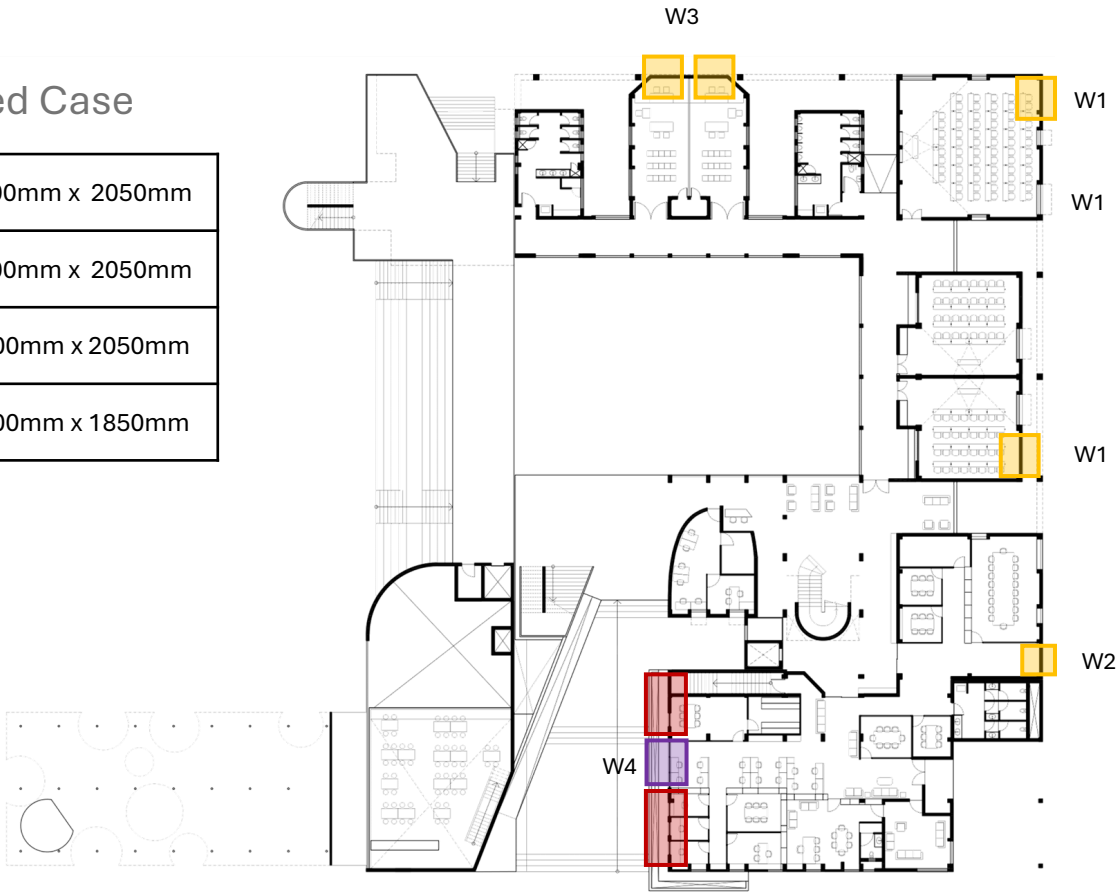
- The fourth and fifth floors similar to third floor have good daylight levels.
- Only glare control needs to be looked at.

Observations: Overall daylight levels in lower floors need addressal. Solar ingress at all floor levels and openings in all directions need to be controlled with suitable shading device proposals.

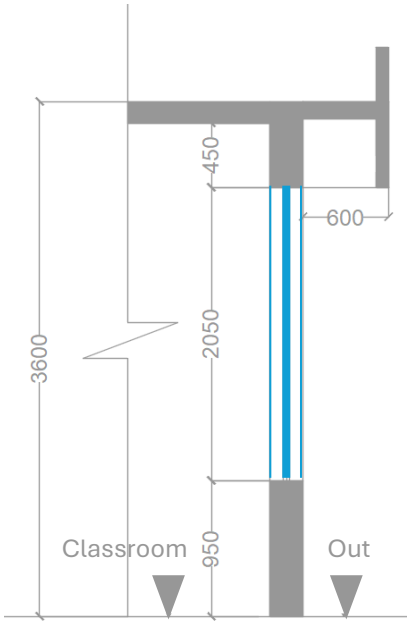


Proposed Case

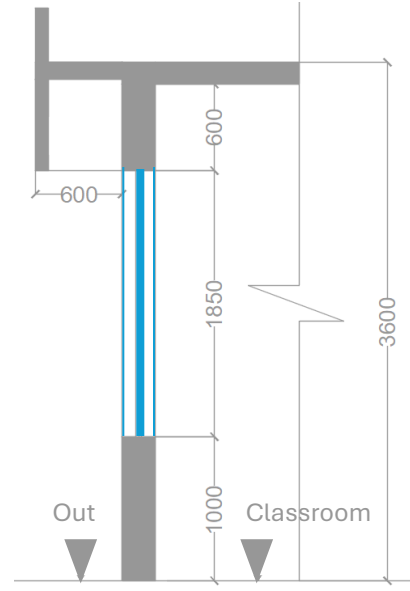
W1	1200mm x 2050mm
W2	1800mm x 2050mm
W3	1500mm x 2050mm
W4	1200mm x 1850mm









Ground floor



W1, W2, W3



W4

-  Addition of overhangs (like existing building) of 750mm deep
-  Window sizes modified with overhangs (like existing building) of 750mm deep
-  Window (like existing building) added with overhangs
-  Windows with Fins of 750mm depth
-  Daylight windows of 700mm deep
-  Windows sizes modified with overhang and fins of 750mm deep

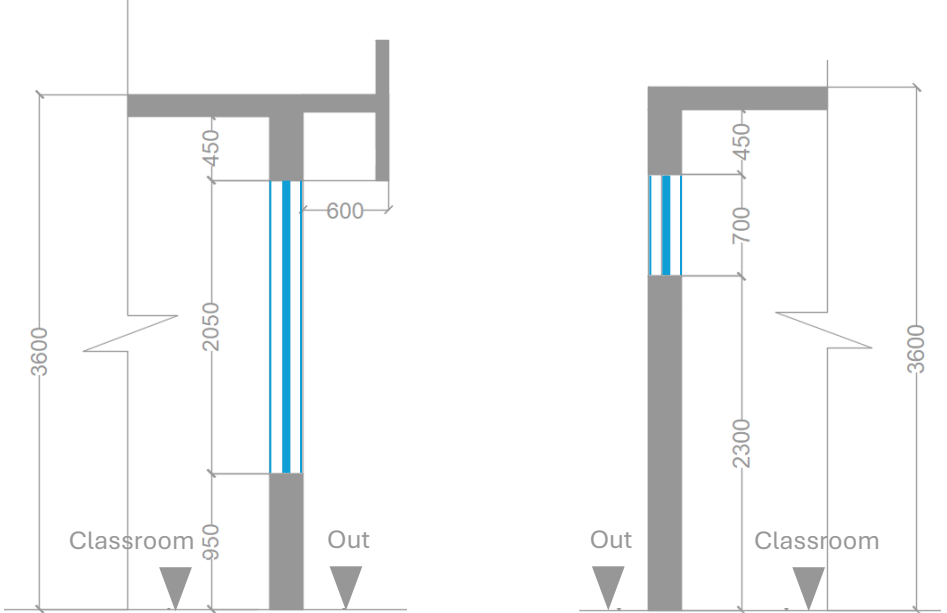


Proposed Case

W1	1200mm x 2050mm
W2	1800mm x 2050mm
W3	1500mm x 2050mm
W4	1200mm x 1850mm

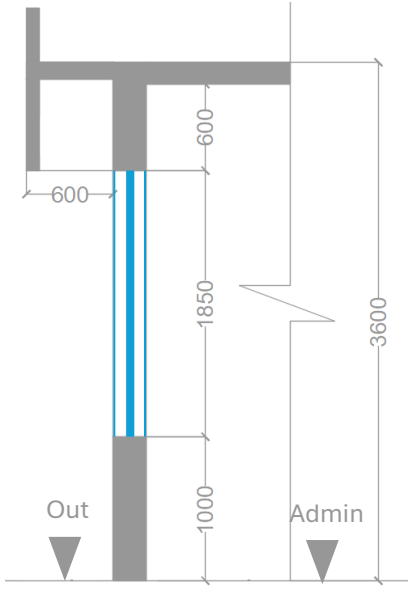


First floor








W1, W2, W3

Clerestory Window



W4

-  Window sizes modified with overhangs (like existing building) of 750mm deep
-  Window added with overhangs
-  Jaali wall
-  Clerestory windows of 700mm high
-  Windows sizes modified with overhang and fins of 750mm deep



Proposed Case

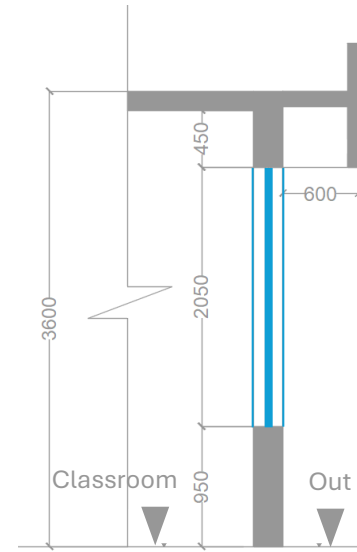
W1	1200mm x 2050mm
W2	1800mm x 2050mm
W3	1500mm x 2050mm
W6	970 mm x 2200mm
W6-A	450 mm x 600mm (Window) 450mm x 1600 (Vent)
W7	1800 mm x 2200mm
W8	2400mm x 1850mm

W6,
W6-A

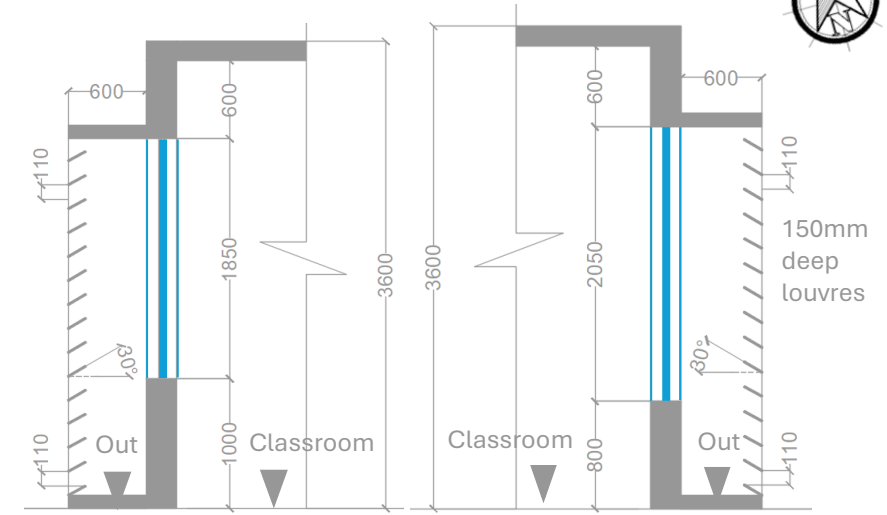


Second floor

- Louvered screen
- Window added with Louvered screen at 1200mm depth
- Daylight windows
- Windows moved to North with flanked by 750mm deep fins and overhangs
- Sill of windows modified with overhangs of 450mm deep, daylight panel and vents are provided

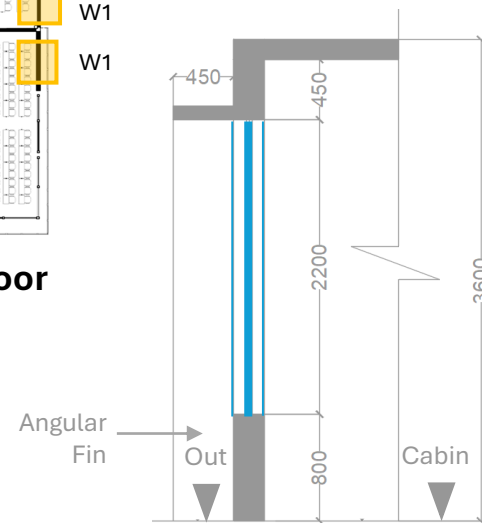


W1, W2, W3

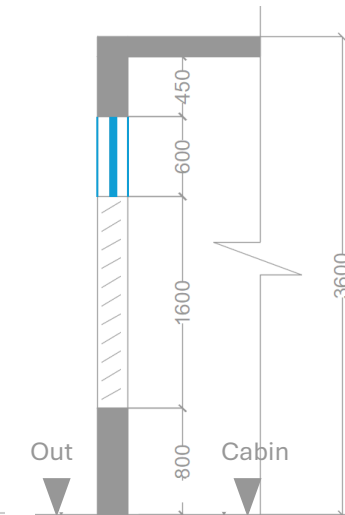


W8

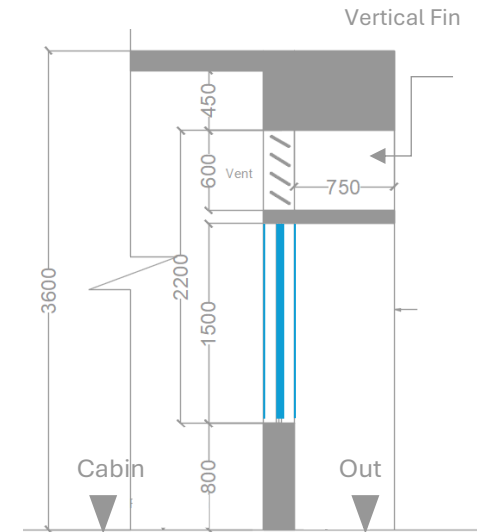
W9



W6



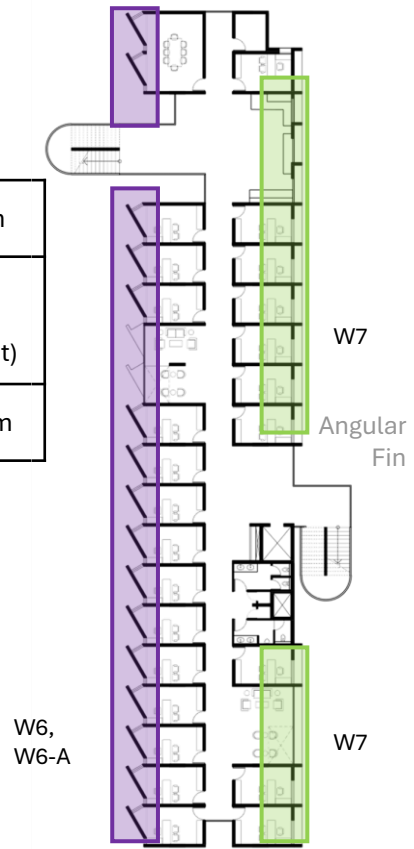
W6-A



W7

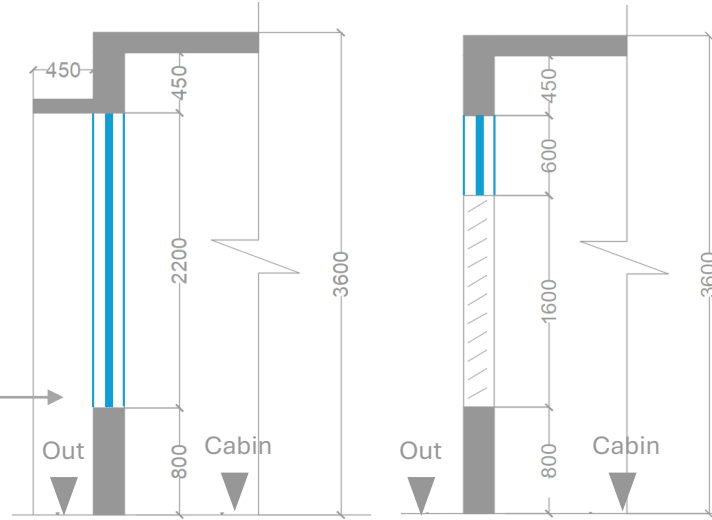
Proposed Case

W6	970 mm x 2200mm
W6-A	450 mm x 600mm (Window) 450mm x 1600 (Vent)
W7	1800 mm x 2200mm



**Typical floor
(Third, Fourth and Fifth Floor)**

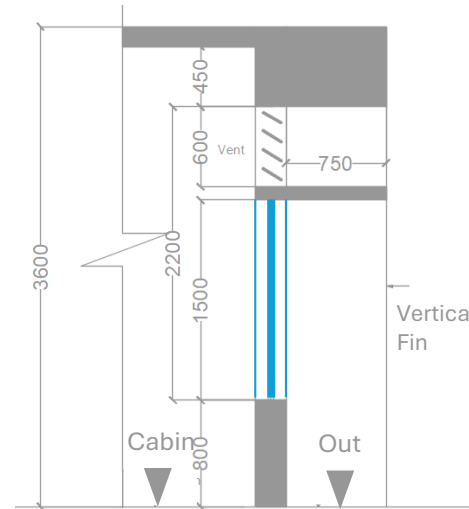
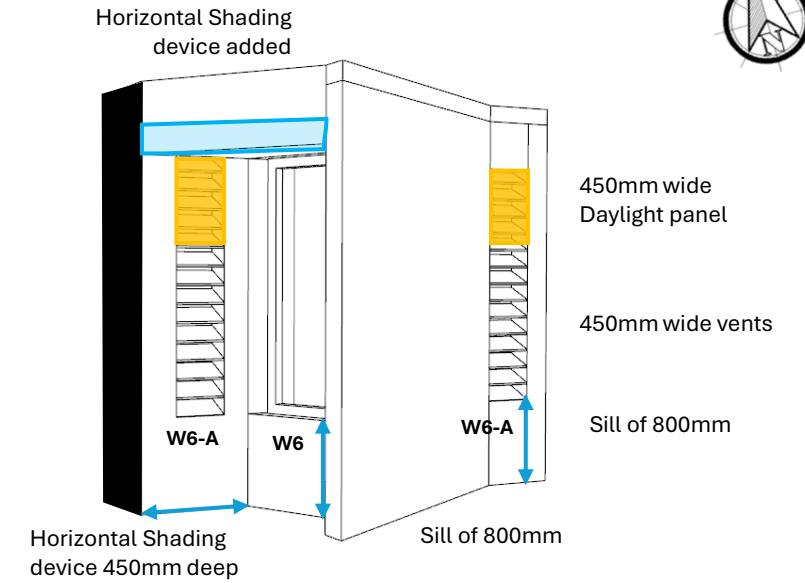
- Windows moved to North with flanked by 750mm deep fins and overhangs
- Sill of windows modified with overhangs of 450mm deep, and vents provided



W6

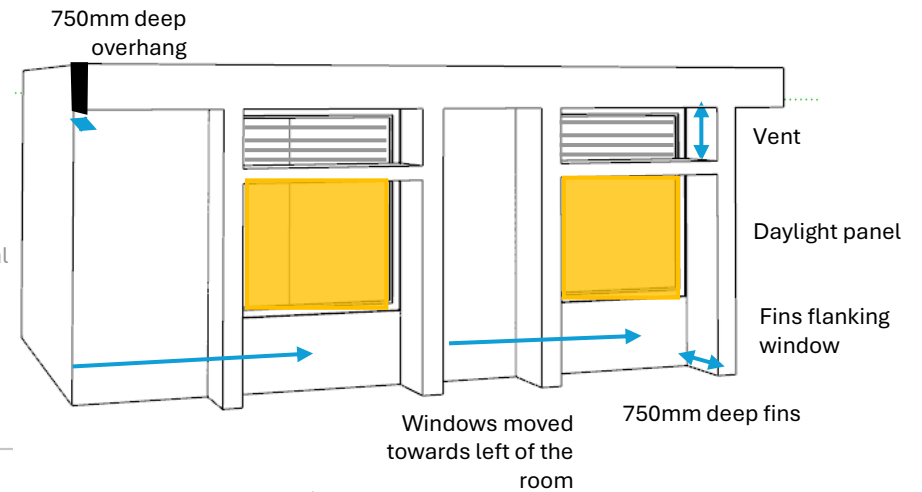
W6-A

West Faculty Cabin (W6, W6-A)



W7

East Faculty Cabin (W7)



Thermal Comfort

Natural Ventilation Analysis with Parametric Study

Base case

- 200mm Concrete Block Wall



Case 1

- 200mm AAC Blocks



Case 2

- 200mm CSEB Wall



Case 3

- PUF Roof Insulation



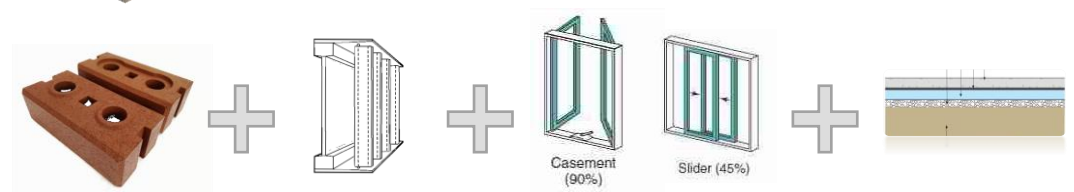
Case 4

- Optimized windows and shading devices + Efficient Glazing



Case 5

- 200mm CSEB Wall + Optimized windows and shading devices + Efficient Glazing + Roof Insulation + Night Ventilation



Thermal Comfort – Second Floor

Natural Ventilation Analysis with Parametric Study

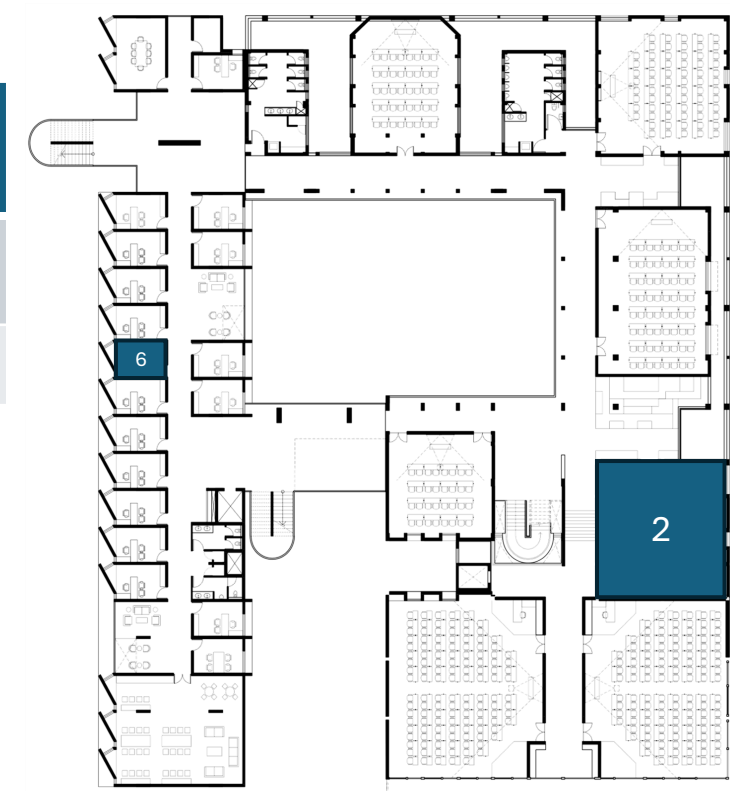
% of Comfort Hours

Sl.No	Spaces	Baseline Case	AAC Block - 1	Mud Block - 2	Roof Insulation - 3	Optimized Glass - 4	Optimized Case – 2+3+4+ Night Purge
1	Faculty Cabin	66%	60%	75%	75%	78%	85%
2	Classroom	63%	58%	66%	60%	67%	81%

Roof insulation PIR thickness – 50mm

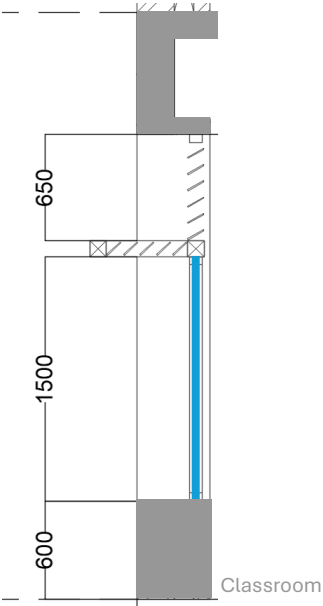
Night Purge – Window / Ventilator Open during nighttime

Glass specs - U Value 5.6 W/Sqmk, SHGC – 0.65, VLT – 67%

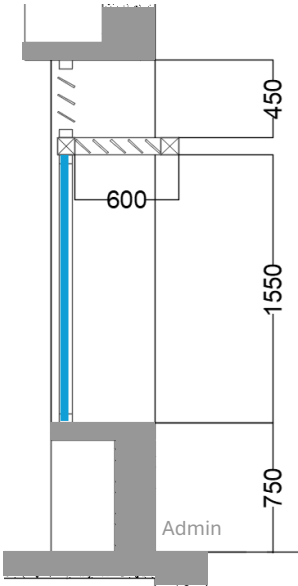


CONSIDERATIONS

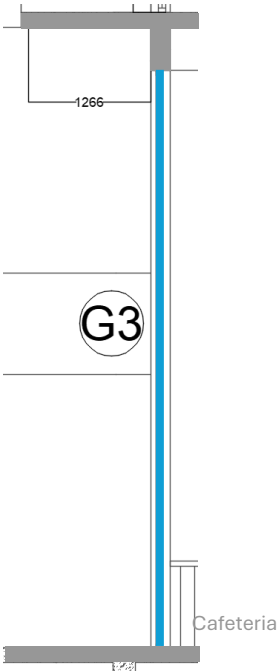
1. Classroom - East



2. Admin



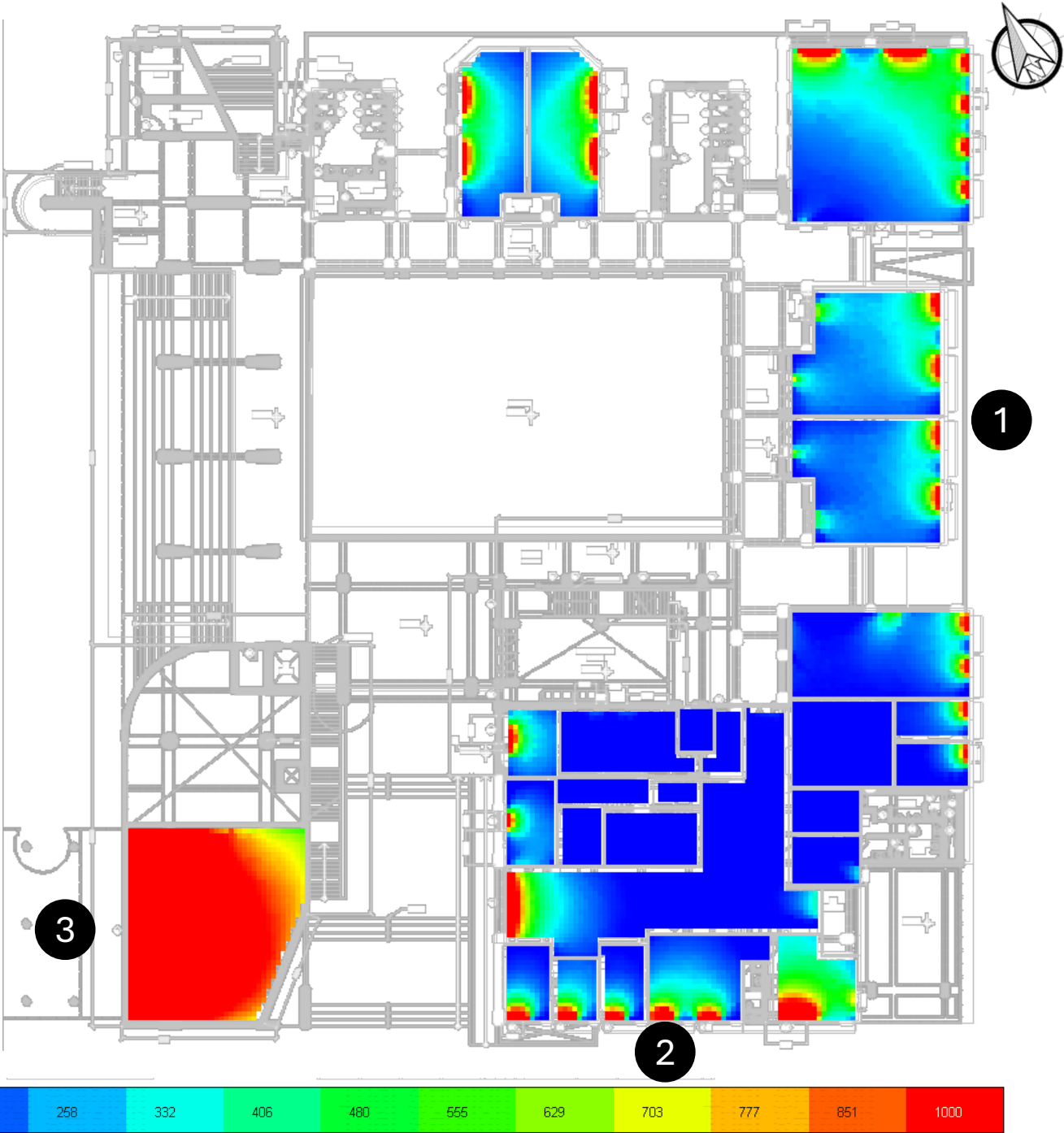
3. Cafeteria



Additional shading on west for cafeterias may reduce the direct sun ingress.

Point in time Illuminance:
September 21, 12 PM

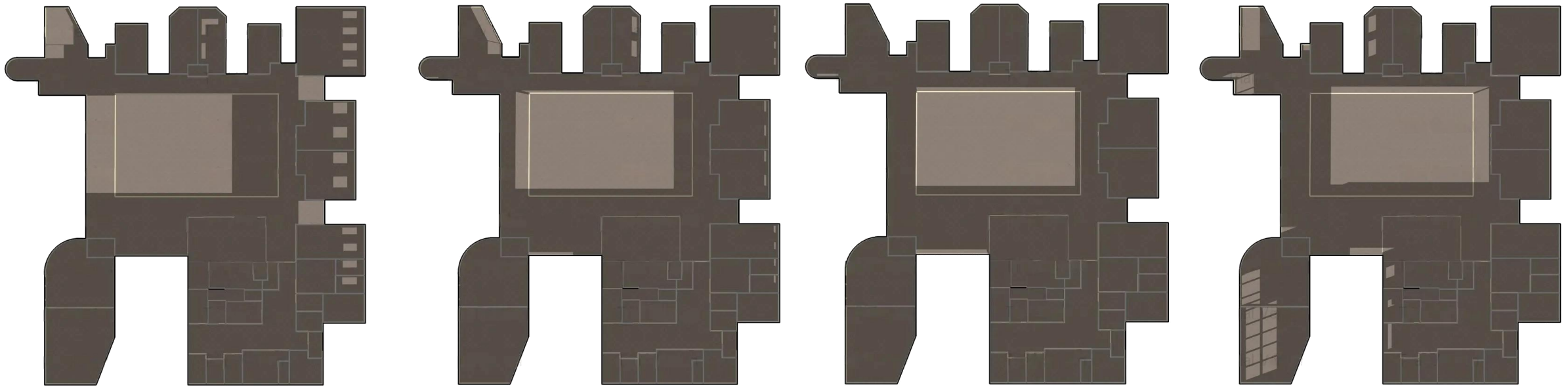
Sl. No.	Illuminance levels (lux)	Percentage Area (%)
1	110 - 1000	61.314



Revised Design Case

Solar Ingress Analysis – March 21st

Ground floor



08:00

10:00

12:00

15:00

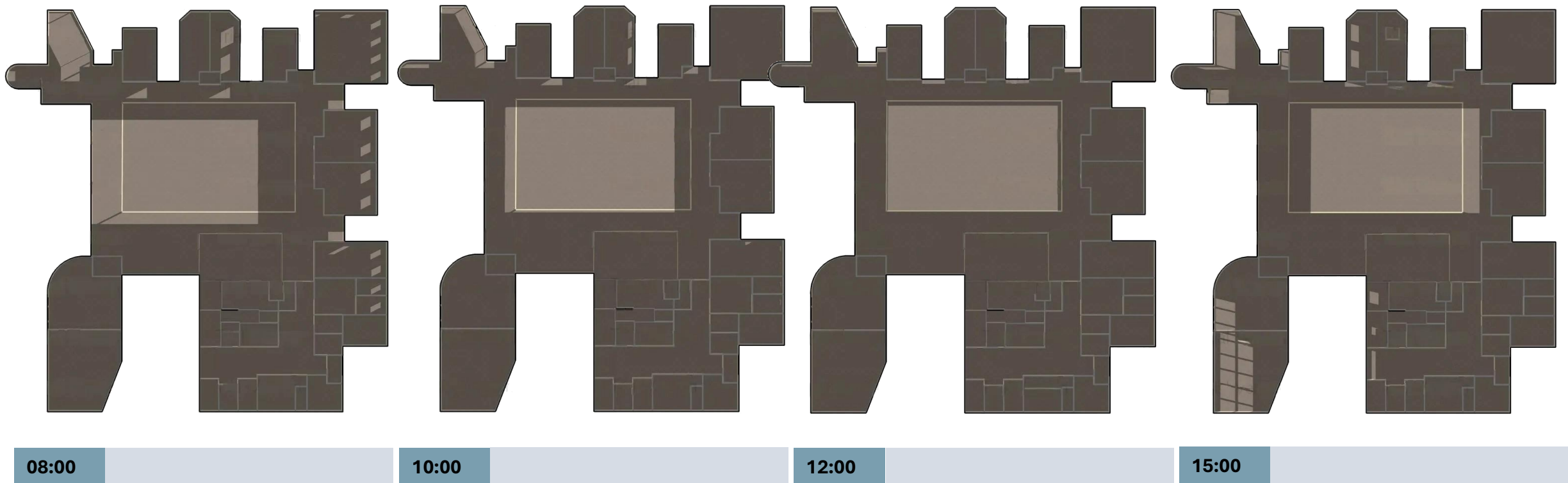
Observation:

- The Classrooms on East receive direct sunlight during morning hours between 8AM to 10AM
- The cafeterias receive ingress after 15PM which can be reduced by additional shading
- The trees around help in glare reduction on all sides

Revised Design Case

Solar Ingress Analysis – June 21st

Ground floor



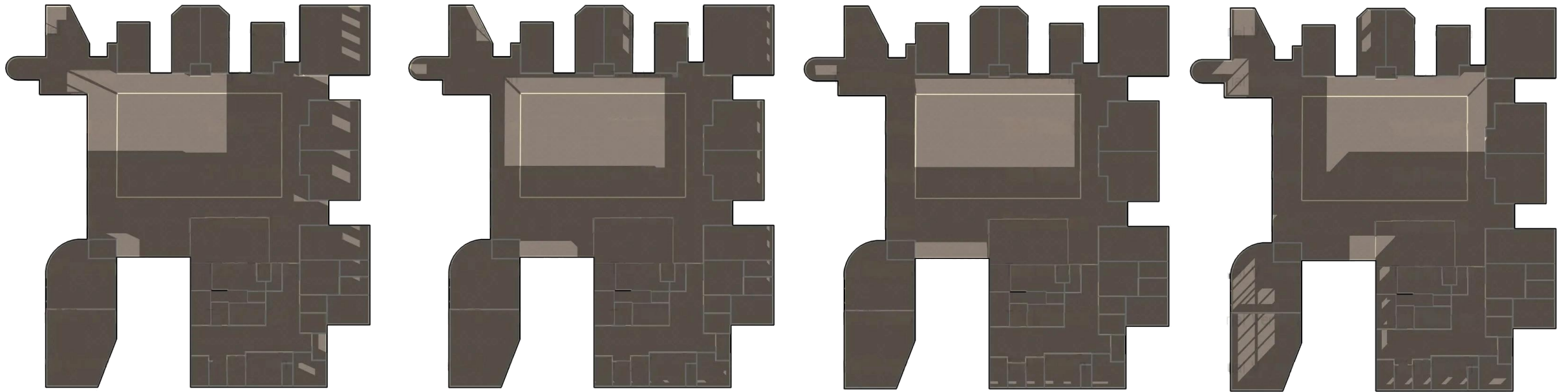
Observation:

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- The cafeterias receive ingress after 15PM which can be reduced by additional shading
- The trees around help in glare reduction on all sides

Revised Design Case

Solar Ingress Analysis – **December 21st**

Ground floor



08:00

10:00

12:00

15:00

Observation:

- The Classrooms on East receive direct sunlight during morning hours between 8AM to 10AM.
- The cafeterias receive ingress after 15PM which can be reduced by additional shading
- The trees around help in glare reduction on all sides

CONSIDERATIONS

1. Classroom - South



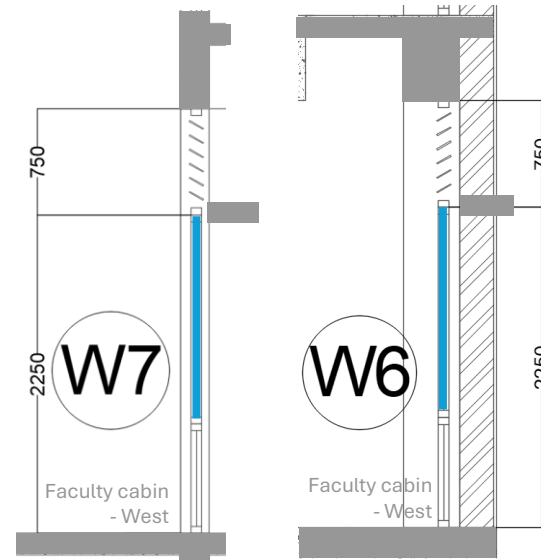
2. Classrooms – Towards courtyard



Point in time Illuminance:
September 21, 12 PM

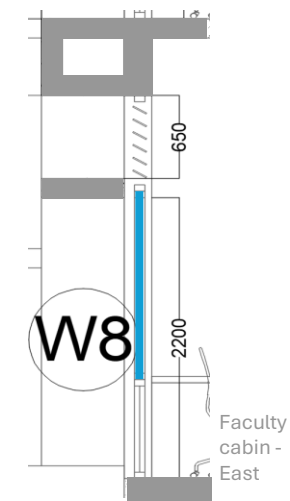
Sl. No.	Illuminance levels (lux)	Percentage Area (%)
1	110 - 1000	84.795

3. Faculty Cabins - West

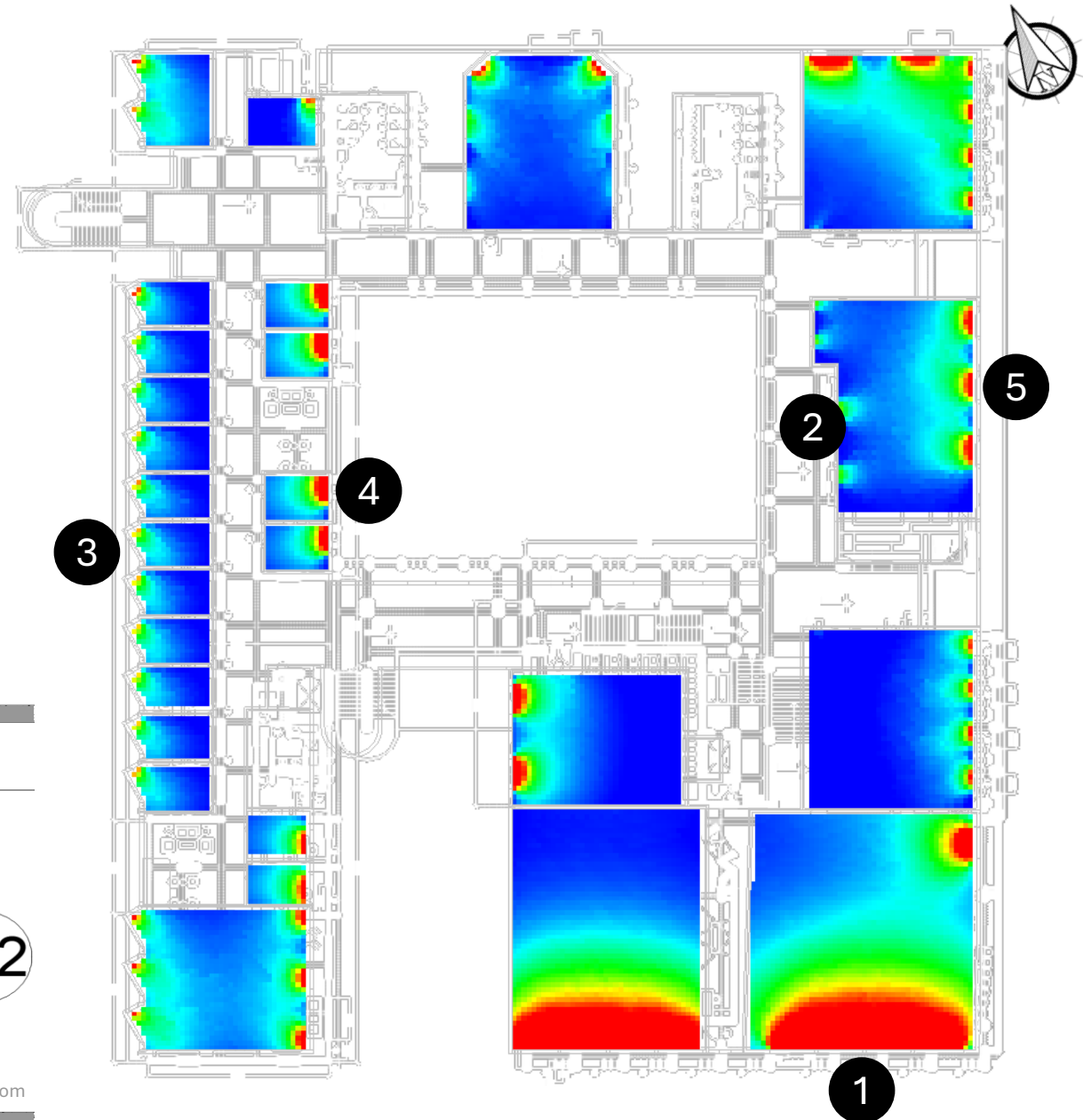
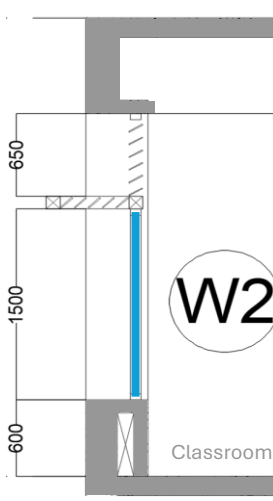


Requires overhang shading to cut ingress

4. Faculty Cabins - East



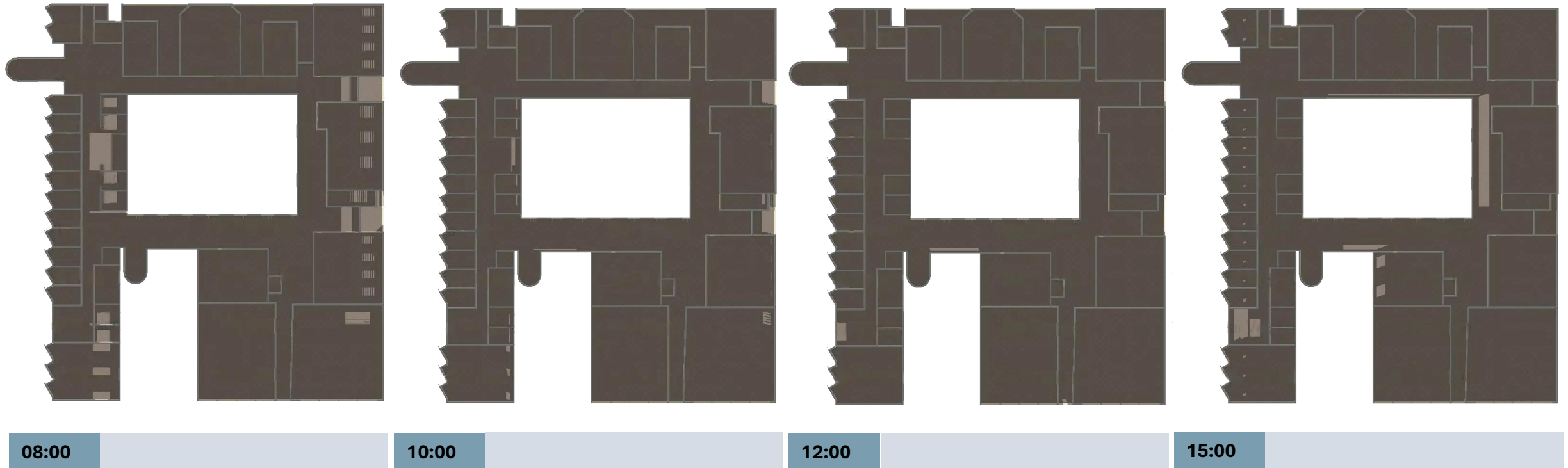
5. Classroom - East



Revised Design Case

Solar Ingress Analysis – March 21st

Second floor



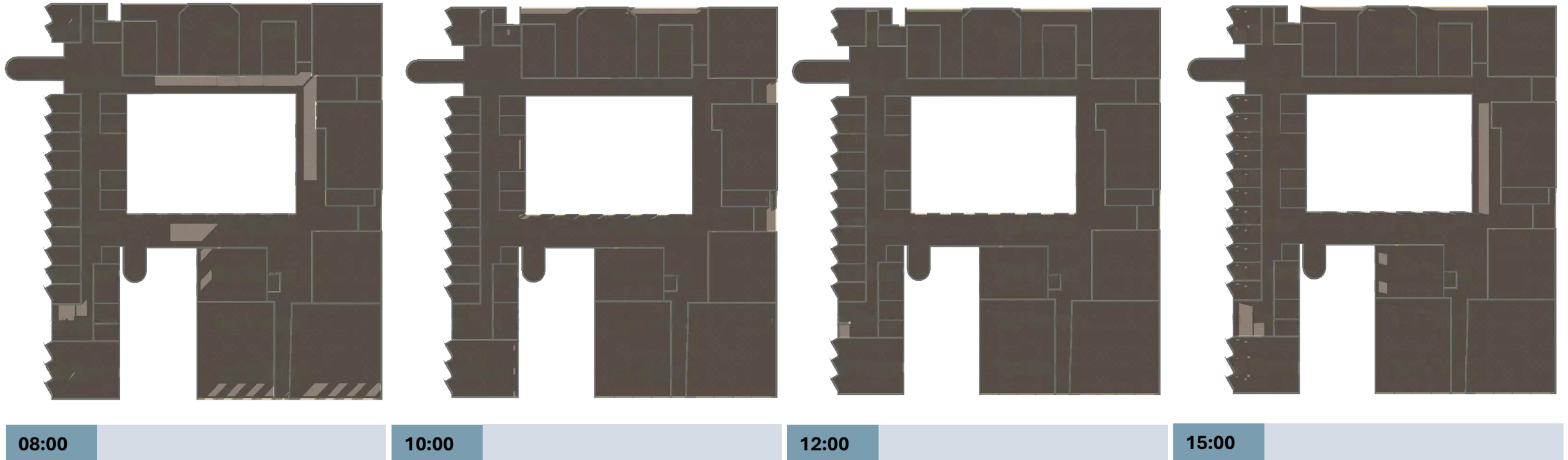
Observation:

- The Classrooms on East receive direct sunlight during morning hours between 8AM to 10AM. Reducing the width of the windows help in reducing the ingress
- The trees around help in glare reduction on all sides

Revised Design Case

Solar Ingress Analysis – June 21st

Second floor



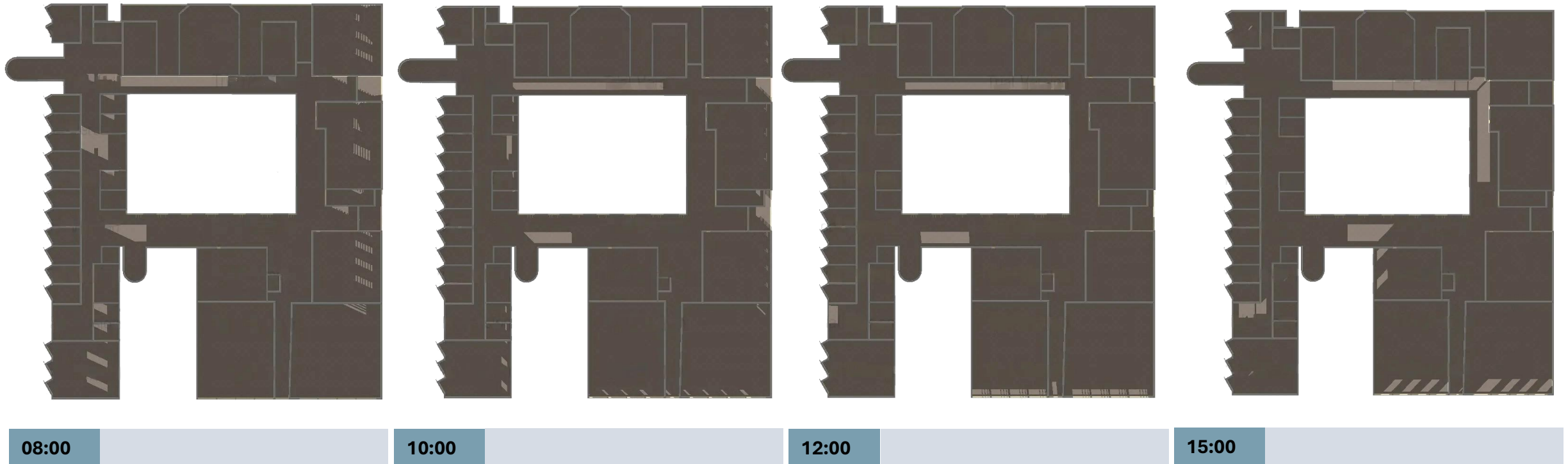
Observation:

- The Classrooms on East receive direct sunlight during morning hours between 8AM to 10AM. Reducing the width of the windows help in reducing the ingress.
- The classrooms on South receive solar ingress from 8AM to 9AM
- The trees around help in glare reduction on all sides

Revised Design Case

Solar Ingress Analysis – **December 21st**

Second floor



Observation:

- The Classrooms on East receive direct sunlight during morning hours between 8AM to 10AM. Reducing the width of the windows help in reducing the ingress.
- The trees around help in glare reduction on all sides

Thermal Comfort – Second Floor

Natural Ventilation Analysis with Parametric Study

CONSIDERATIONS

- **Wall** – 200mm CSEB wall with hollow clay tile cladding
- **Roof** – RCC roof with 50mm PIR insulation
- **Night Purge** – Windows and Ventilator open during nighttime in classrooms
- **Glass spec** – U value of 5.6 W/sq.m.K, SHGC of 0.65 and VLT of 67%
- **Shading**- as per design proposal

Note: Only operational hours, and months have been considered for the comfort analysis.

% of Comfort Hours

Sl. No.	Space	% of Comfort Hours
1	Classroom 2	77.5%
2	Classroom 7	75.4%
3	Faculty Lounge	75.0%
4	Faculty Cabin 7	77.9%
5	Faculty Cabin 12	76.8%
6	Meeting Room	73.6%

