Mandaue City Mixed Income & Use Development

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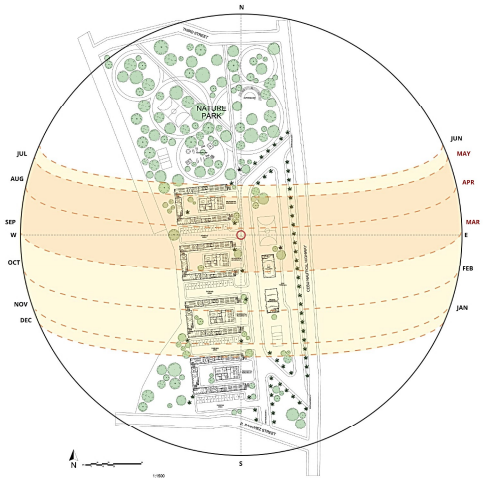
LIGHTING FINAL PLATE | ARCH 143 MSNOP | PROF FLORES-BERNARDO

Sun Paths



March to **May** are the hottest months and the months with the most daylight exposure in the Philippines

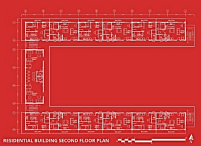
Daylight Strategies

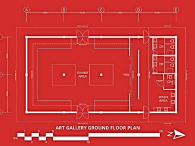
SITE
- The chosen site is in a large open area, with minimal, if any, obstructions to daylight
- The on-site residential buildings are oriented along the E-W axis
- The on-site residential buildings are laid out side by side along the N-S axis, allowing each building to shade each other from afternoon sun, without them being daylight obstructions to each other
- The side by side layout of the buildings provides shade for the parking areas beside each building
- A tree-filled public park area in the north of the site allows light to enter gently through patches in between leaves, creating a pleasant area for outdoor recreation

BLDG FORM

Residential Buildings
- The buildings' east facing openings allow morning sun to reach deeper into the building without letting afternoon and late afternoon light do the same
- Since the central ground floor areas of the buildings are public space, the daytime light that pours into this area acts as an invitation for visitors
- The cove shape of the buildings opens up the central ground floor areas of the buildings to the public recreational spaces and art buildings in front of them, and even lighting between the two areas reinforces a connection between them

Art Gallery and Workshop
- The single storey forms of the art and commercial buildings make it so that they do not cast shadows on the main residential buildings





SCHEMATIC DESIGN

Residential Buildings
- Hallways in the building are exterior walkways, and rooms are single banked. This allows rooms to have windows on both sides, and receive abundant sunlight.
- Similarly, the building's main stairways are open and allow light to pass through the gaps between floors and flights of stairs
- Rooms are laid out with their long sides facing the hallways and exterior, reducing room depth and increasing surface area for possible windows
- Rear balconies are provided for the units, allowing for full height openings to the inside. In addition to this, each terrace acts as sun shading for the unit below, like how the hallways do for the fronts of the units

Art Gallery and Workshop
- The two art buildings are provided with rows of awning windows that allow for sufficient daylighting and ventilation
- The high ceiling of the two buildings allows for higher openings that let in more uniform daylight with minimimal glare
- The open plan of the art gallery allows light to fill the space uniformly and without obstruction
- Wide (1 meter) eaves are provided for both roofs of the buildings, ensuring that there is ample sunshading for all of their openings

Conceptual Lighting Design
Interior- Art Gallery

APPROACH- Ambient-Task
- **General Lighting-** Overhead suspended lights will provide a bright, even, and comfortable lighting base with general lighting, supported by daylight provided by the building's awning windows and by the additional task lights
- **Task Lighting-** Additional overhead spotlights will be used to highlight the artworks on display and bring out their detail and color

ILLUMINATION REQUIREMENTS
- 300 lux (IESNA- exhibit spaces)

ADDITIONAL REQUIREMENTS
- At least 90 CRI (accurate color matching)
- 4000K Temperature (white)

LUMINAIRE SPECIFICATIONS
- **General Lighting-** TrueLine Suspended SP532P LED47S
  - Manufacturer- Philips
  - Type- Suspended beam
  - Luminous Flux- 4700lm
  - Temperature- 4000k
  - Maintenance (LLD)- 0.90


Trueline luminaire (Image from Philips)

- **Task Lighting-** TrueFashion ST715T LED27S
  - Manufacturer- Philips
  - Type- Spotlight
  - Luminous Flux- 2700lm
  - Temperature- 4000k
  - Maintenance (LLD)- 0.90


TrueFashion spotlight (Image from Philips)

VIEWS OF SPACE


8:00am


4:00pm


8:00pm

ILLUMINATION CALCULATION (LUMEN METHOD) FOR GENERAL LIGHTING

1. Required Data
- room length= 14.45m
- room width= 10.3m
- room height= 4.8m
- LDD= 0.94 (light, open & ventilated)
- Target illumination= 300 lux
- hfc= 1.0m
- hrc= 2.2m
- hcc=1.6m
- pf= 20% (dark timber)
- pw= 40% (white fiber cement)
- pc= 80% (white paint on plasterboard)

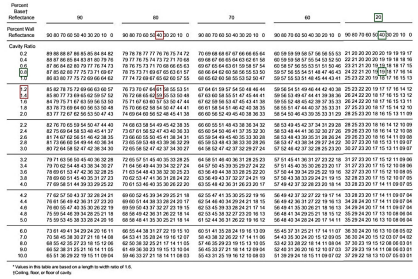
2. Zonal Cavity Calculations

RCR= [(5)(hrc)(l + w)]/(lw)
= [(5)(2.2)(14.45+10.3)]/[(14.45)(10.3)]
= 1.83

FCR= RCR(hfc/hrc)
= (1.83)(1.0/2.2)
= 0.83

CCR= RCR(hcc/hrc)
= (1.83)(1.6/2.2)
= 1.33

3. Effective Reflectances *(Table from IESNA)*



ρfc= 18.38%= 0.19
ρcc= 59.75%= 0.60

4. Coefficient of Utilization *(Table from Philips)*

Room Index k	Reflectances for ceiling, walls and working plane (CIE)									
	0.80	0.80	0.70	0.70	0.70	0.50	0.50	0.30	0.30	0.00
	0.50	0.50	0.50	0.50	0.30	0.50	0.30	0.30	0.10	0.00
	0.30	0.10	0.30	0.10	0.10	0.10	0.10	0.10	0.10	0.00
0.60	0.63	0.59	0.60	0.59	0.58	0.53	0.50	0.48	0.46	0.41
0.80	0.71	0.66	0.68	0.66	0.64	0.59	0.56	0.53	0.50	0.46
1.00	0.78	0.72	0.74	0.72	0.69	0.65	0.61	0.58	0.57	0.51	0.49
1.25	0.84	0.77	0.80	0.77	0.74	0.70	0.65	0.63	0.60	0.59	0.53
1.50	0.89	0.80	0.84	0.81	0.77	0.73	0.68	0.66	0.63	0.61	0.54
2.00	0.96	0.86	0.91	0.86	0.82	0.78	0.73	0.71	0.67	0.64	0.56
2.50	1.01	0.89	0.95	0.90	0.85	0.83	0.76	0.74	0.70	0.69	0.60
3.00	1.04	0.91	0.98	0.93	0.87	0.85	0.78	0.77	0.72	0.71	0.61
4.00	1.09	0.94	1.02	0.95	0.90	0.88	0.81	0.80	0.73	0.73	0.63
5.00	1.11	0.95	1.04	0.97	0.91	0.90	0.82	0.81	0.75	0.74	0.64

ρcc= 20%= 0.20
ρw= 40%= 0.40
ρ working plane= 25% (medium timber)
*For the reflectances, the column with the closest values was used

RCR= 1.83

CU= 0.835

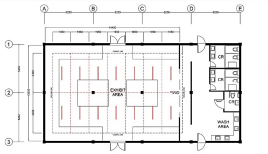
5. Light loss Factor

LLF= (LLD)(LDD)(BF)
= (0.9)(0.94)(1)
= 0.846

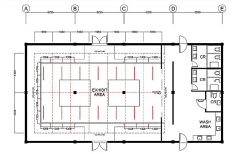
6. Number of Luminaires

N= [(E(A))/[(n)(LL)(LLF)(CU)]
= [(300)(148.835)]/[(1)(4700)(0.846)(0.835)]
=13.44= **14 Luminaires**

5. Lighting Layout



GENERAL LIGHTING LAYOUT



COMPLETE LIGHTING LAYOUT

*No spacing criteria was given, so the available space was divided equally between the general lights

*To fit the lights within the space of the second ceiling, the total occupied area was reduced to the area within the space of the second ceiling

Suspended Lights
Spotlights

Conceptual Lighting Design
Exterior- Main Street

APPROACH- General-Ambient
- Provide bright, even, and comfortable lighting along the main street of the site, ensuring the safety and comfort of passersby without being attention grabbing or distracting
- Regular spacing in between the lamp posts will ensure uniform light distribution
- Down-facing lights will be used to limit light pollution and skyglow

ILLUMINATION REQUIREMENTS
- 50 lux (CIE/Engineering Toolbox- public areas)

ADDITIONAL REQUIREMENTS
- Limit light pollution, particularly skyglow
- 3000K Temperature (warm)

LUMINAIRE SPECIFICATIONS
- GreenVision Xceed Gen2 BRP381 LED71
  - Manufacturer- Philips
  - Type- Analog Street lamp
  - Luminous Flux- 7100lm
  - Temperature- 3000k
  - Maintenance (LLD)- 0.70


Greenvision street lamp (Image from Philips)


Perspective of main street (daytime)


Cut-out representation of the street lamp layout

Analysis & Summary

SITE DEVELOPMENT

A large focus of the site development was the integration of natural, beneficial, light. Exposure to sunlight, particularly morning sunlight was a goal to be achieved in all of the spaces. To achieve this goal, extra emphasis was placed on the position and orientation of all of the buildings.
- The main residential buildings were all aligned with their long sides along the E-W axis to maximize daylight exposure. When paired with the daylight-maximizing orientation of the units themselves, this also leads to energy saving as residents and users can rely more on daylight as opposed to artificial light for more hours of the day.
- The cove shape of the main buildings was an important design consideration that was deeply tied with the concept of the site and the history of the city it is in. However, at four storeys tall, there was the danger that the interior courtyards of the buildings would barely receive sunlight, which was a problem as these interior courtyards were meant to be places for recreation and socialization, and sunlight would greatly benefit that. Orienting the buildings towards the east ensures that morning light would be able to light up these spaces and enhance their energy.

Recommendation: the orientation of the art buildings could be adjusted by 90 degrees so that they too would have their long sides along the E-W axis, and have the same benefits the main building enjoys with regards to daylighting. Doing so would also improve light quality within the buildings as it would limit the harsh late-afternoon light that enters them.

INTERIOR MAIN SPACE- Art Gallery

The art gallery has special needs with regards to lighting due to its nature. As an exhibit space for art pieces that would rotate and change over time, the lighting of the space would need to be able to bring out the best in the exhibited works, while also being versatile enough to support different exhibit setups. It must also create or enhance an environment conducive for appreciating art.
- The task-ambient lighting approach was used as this approach allows for a space to be adequately lit as a whole, while still being able to bring focus to certain parts of the space, which is exactly what needs to be achieved within an art gallery. As mentioned in the previous section, general lighting provided by the suspended beam lights creates a pleasant lit environment that can act as a base for any further modifications with the spotlights. All of the chosen lights had a CRI of at least 90 which is the standard for art galleries, and were of a neutral white temperature (4000k) which would allow them to enhance the visuals of the art on display without modifying how they look. Lighting computations for these were done in consideration of the average height of a displayed piece when on a platform (1 meter), and of the typical material that these pieces would be made of (wood). The luminaires were then positioned accordingly.
- The art gallery exclusively uses overhead awning windows for ventilation and daylighting. This was decided because the artworks on display could best be appreciated and displayed in a controlled environment that could be adjusted on a case to case basis, and windows or any permeable surfaces behind or near the works would detract from that. The placement of awning windows overhead on all four sides make up for the lack of traditional windows, providing uniform daylight and ventilation without taking focus away from the artworks. The location of the windows high up, the decision to make them short in height, and the provision of wide eaves also ensure that the windows produce minimal glare.

Recommendations: To greater enhance the exhibit space with lighting, and to accommodate possible changes in exhibit layouts, additional spotlights, or the use of spotlights with a rotation capability are recommended. Automated blinds systems could also be installed to block out the windows entirely when there is unpleasant lighting, or if darkness is ever required for an exhibit.

EXTERIOR SPACE- Main Street

While it is a vehicular street, the main street of the site is expected to experience high pedestrian and cyclist traffic. thus, necessary lighting interventions must be provided for the safety of these users. As such, regularly spaced lamp posts were placed on both sides of the street. These lamp posts would provide uniform lighting that would make passersby feel safer when walking or cycling along the street, without being distracting or glaring for both passersby and motorists. These lamps would also be strictly down facing in their design to minimize light pollution.

Recommendation: Using solar powered lamp posts would be ideal to save energy costs and reduce carbon footprint.

OVERALL EFFECT OF LIGHTING ON DESIGN

Lighting has enhanced this project in both a utilitarian and aesthetic sense. With proper and thought-out lighting considerations, shortcomings of the design, such as dark courtyards, possibly unsafe streets, and the risk of glare, are overcome, and these spaces became able to function better, and even something as simple as building orientation presents improvements in both mood and productivity, particularly in the residential units. As for the art gallery, the designed lighting layout allows for any artwork to be displayed within the building in confidence, as the lights were chosen and laid out specifically for the purpose of exhibiting these pieces. Without the considerations that led to the gallery's lighting design, the space would not be able to function effectively at all. In fact, the same is true for the entire development. Each of the spaces on-site has specific goals: to foster an environment for socialization, improve the presentation of an art piece, or create feeling of comfort in a living room, and it is with lighting that these goals are met, and they are met well. Architectural lighting is not simply an addition to an already existing design. It certainly was not for this project. It was a consideration from the beginning, acting as a foundation for the design of the buildings and the layout of the site itself, and it is what has allowed the spaces within the Mandaue City mixed-use development to reach their full potential.

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