LIGHTING DESIGN OF ARCHITECTURAL INDOORS AND FAÇADE OF A BUILDING USING MODERN LED TECHNOLOGY

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENT FOR DEGREE OF

MASTER OF ENGINEERING

IN

ILLUMINATION ENGINEERING

SUBMITTED BY

BISWAJIT SARDAR

Exam Roll No:**M4ILN24020**

UNDER THE SUPERVISION OF

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CERTIFICATE OF RECOMMENDATION

This is to certify that the thesis entitled "**LIGHTING DESIGN OF ARCHITECTURAL INDOORS AND FAÇADE OF A BUILDING USING MODERN LED TECHONOLOGY**," submitted by BISWAJIT SARDAR (**M4ILN24020**) of this university in partial fulfillment of requirements for the award of degree of M.E in Illumination Engineering, Department of Electrical Engineering, is a Bonafede record of the work carried out by him under my guidance and supervision.

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FINAL EXAMINATION FOR EVALUTION OF THESIS.

BOARD OF EXAMINERS

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DECLARATION OF ORIGINALITY AND COMPLIANCE OF ACADEMIC ETHICS

I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as part of his ME in Illumination Engineering studies during academic session 2023-2024.

All information in this document has been obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by this rules and conduct, I have fully cited and referred all material and results that are not original to this work.

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ROLL NUMBER: M4ILN24020

THESIS TITLE: **LIGHTING DESIGN OF ARCHITECTURAL INDOORS AND FAÇADE OF A BUILDING USING MODERN LED TECHONOLOGY**

SIGNATURE:

DATE:

ACKNOWLEDGEMENT

At the very Beginning, with immense gratitude, I show my gratitude and acknowledge the support, help extended by my supervisor, (Dr.) SASWATI MAZUMDAR, Electrical Engineering Department, Jadavpur University whose encouragement and phenomenal supervision and visionary guidance from the preliminary to the concluding level enabled me to complete this project work.

I would like to acknowledge my sincere thanks to, Mr. SHUBHAJIT DAS and Mr. SAIKAT KURI, Manager at Wipro Lighting for providing me the opportunity to carry out my project work at Wipro Lighting.

I am very glad to express my deep regards to Mr. Anant Deshpande (Sr. Manager,) of Wipro Consumer Care and Lighting for their valuable inputs and immense support for carrying out my project in Wipro Consumer Care and Lighting.

Last but not the least, I wish to convey my immense gratitude to my parents, whose love, teachings, and support have brought me this far.

BISWAJIT SARDAR

CONTENTS

INTRODUCTION

The primary goal of indoor lighting design is to give rooms the appropriate amount of light while minimizing glare and maintaining precise homogeneity.

Indoor lighting consists of mainly Industrial buildings and process, Office, schools, public buildings, conference room, hospital, restaurants, surgeries, shops, homes the search for the most energy-efficient lighting solution then continues. Indoor luminaires that use LED lighting have been proven to be more efficient than those that use compact fluorescent, fluorescent, or traditional incandescent lighting. These days, incandescent bulbs are preferred for their short lifespan and tendency to blacken glass, whereas fluorescent lamps are shunned due to their lower efficacy. However, LED luminaires are becoming a more practical choice these days, with significantly higher CRI Indexes (>80) and efficacies (>90lm/W). Both traditional and LED lighting have been used in the design process.

The last section of the work implies how a decorative fitting used in conference room and office room and using DALI controller how dimming features works, which can reduce energy usage. To demonstrate the superiority of LED luminaires over conventional luminaires, a final payback calculation is performed for the design created using LED luminaires. Following the Electro Technical Division Council's approval of the Illuminating Engineering and Luminaires Sectional Committee's final draft, the Bureau of Indian Standards adopted this Indian Standard (Part 1) IS3646. This code's main purpose is to list the considerations that must be made to achieve appropriate lighting.

Facade lighting plays a crucial role in enhancing the visual appeal and functionality of buildings during nighttime. It involves the strategic placement and use of lights to illuminate the exterior surfaces of structures, creating aesthetically pleasing and practical designs. The primary goal of facade lighting is to highlight architectural features, improve safety and security, and establish a distinct identity for the building using DMX controller which helps to provide different scenes of the building.

With advancements in lighting technology, LED luminaires have emerged as the preferred choice for facade lighting. LED systems offer superior energy efficiency, longer lifespan, and greater flexibility in design compared to traditional lighting solutions. Their high Color Rendering Index (CRI) and luminous efficacy enable the accurate and vibrant display of a building's facade, ensuring that the architectural intent is preserved and accentuated.

The implementation of facade lighting requires careful consideration of various factors, including the building's purpose, architectural style, and surrounding environment. Properly designed facade lighting can transform a building into a landmark, enhance its nighttime visibility, and contribute positively to the urban landscape.

2.Objectives

The objectives of the thesis are as follows:

The overall aim of the work is to investigate the required lighting of indoor and Façade in Indian condition.

The first goal is to Design and executing for indoor space with DALI Controller.

- General specifications and recommendations for functional interiors
- Glare Index Calculation Methodology for Interiors
- Office Lighting Recommendations
- Recommendation for video conference hall
- DALI installation

The second goal is design and execution of Façade using LED luminaires.

- Site inspection/AutoCAD design submitted by the client.
- Design different scenes
- Making Single Line Diagram
- Addressing the luminaires
- Connecting Beldan Cable with Splitter and DMX Controller
- Programming

IS 3646 was first published in three parts, Part 1 covering principles for good lighting and aspects of design, Part 2 covering schedule of illumination and glare index, and Part 3 covering calculation of coefficient of utilization by the BZ method. Since calculation of coefficient of utilization by the BZmethod has become obsolete, therefore, in the first revision a new method of calculation of glare indices has been introduced.

Parts 1 and 2 of the standards, when completed, will supersede IS 3646 (Part 1): 1966, IS 3646(Part 2), and IS 3646 (Part 3): 1968. Subsequent parts of the standard are intended to cover additional requirements that should be fulfilled while designing the lighting for a specific area. With the publication of these parts, the existing standards relating to code of practices for individual areas will, therefore, be ultimately withdrawn. In the preparation of this standard, assistance has been derived from draft CIE-Publication on Interior Lighting, DIN 5035 (Parts 1 and 2): 1979 and CIBS Code for Interior Lighting, 1984. [1,2]

3.FEATURES OF LED LUMINAIRES

White light-emitting diodes, or LEDs, are the light source used in WLED (White Light Emitting Diode) luminaires. Semi-conductor devices known as LEDs release light when an electrical current flows through them. White light is produced by WLED luminaires by combining many colored LEDs—typically blue or ultraviolet LEDs—with a phosphor coating. The blue or ultraviolet light that the LEDs emit is changed into a wider spectrum of light by the phosphor coating, producing an output of white light. The phosphor coating's composition and thickness can be changed to change the white light's color temperature.

WLED luminaires' many benefits have LED to their increasing acceptance in a wide range of lighting applications. When it comes to energy consumption, they are far more energy-efficient than conventional lighting sources. Additionally, because of their extended lifespan, they require less upkeep and replacements over time. Excellent color rendering is a feature of WLED lights, which means that the colors of the objects they illuminate are precisely represented. They offer a large variety of color temperatures, ranging from warm to cool, making it possible to customize them to fit various tastes and settings.

Types of LED Chip:

A light-emitting diode chip, or LED chip for short, is a type of semiconductor that, when an electric current flows through it, creates light. It is an LED's (light-emitting diode) central component. Semiconducting semiconductors like gallium arsenide (GaAs) or gallium nitride (GaN) are commonly used in the production of LED chips.

For protection and electrical connections, LED chips are usually placed on a substrate and encased in an epoxy resin or ceramic packaging.

For practical usage, these packed LED chips can subsequently be incorporated into a variety of electronic gadgets and lighting installations. There are essentially three kinds of LED chips. [10]

- DIP Chip
- SMD LED Chip
- COB LED Chip

1.**DIP Chip:**

The conventional LED lights are called DIP (Dual In-Line Package) LEDs. When most people see LED lights, this is what comes to mind. They resemble a regular lamp the most since the chip is usually connected by two straight, parallel pins and is housed in a hard plastic casing. Even though DIP chips are still in use today, their efficiency is significantly lower than that of the more recent LED chips, which are employed in contemporary applications. These chips are most likely utilized in electronics.

An LED DIP chip will yield substantially less light than the more recent chips—roughly 4 lumens per LED.

Fig:1.1

Fig 1.1 shows the DIP Chip.

2.SMD LED Chip:

Surface mounted diodes, or SMDs for short, are LEDs that are far more compact and effective than DIP chips. Their adaptability has LED to their rise in popularity, and they are usually soldered and put onto a circuit board. Because three diodes may be placed on one SMD chip, these chips have proven crucial to the growth of the LED sector.

Not only do they have far superior brightness, but they can also change color. Certain chips are designed to be tiny so they can be utilized in high-end devices like laptop computer indication lights. Additionally, they are stand-alone chips that are mostly utilized with LED recessed downlights or strips. These SMD chips can produce between 50 and 100 lumens per watt. Which is significantly better than the DIP chip. Below Fig 1.2 shows the SMD LED Chip.

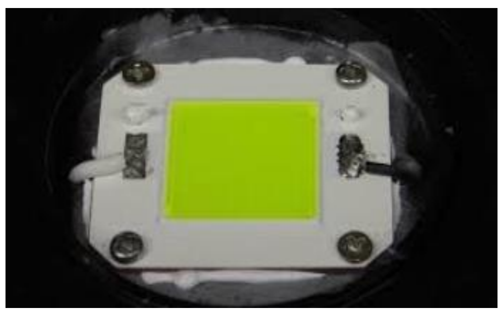


Fig 1.2

3.COB LED Chip:

The newest advancement in LED lighting is the powerful COB (Chip on Board) LED chip. Like SMD chips, COB LEDs have several diodes, usually nine or more. Numerous gadgets use COB chips in their operations. This usually occurs with small devices, like cameras and cellphones, because many lumens are produced for a very small quantity of energy. High power LED floodlights and spotlights are now widely utilized; however, they were not thought of as standard lighting before the invention of the LED COB chip.

The COB chip comes in a variety of configurations, but overall, they may provide a lot more lumens per watt often well over 100. Below Fig 1.3 shows the COB LED Chip.

Fig 1.3

4.Photometric Features

An LED luminaire's photometric attributes include its light output and distribution characteristics. These characteristics are essential for controlling the light's distribution, intensity, color, and overall quality.

Luminous Flux

The entire quantity of visible light that an LED luminaire emits in all directions is referred to as its luminous flux. It is a measurement of the total amount of light output brightness and is commonly represented in lumens (lm). Lumi-nous flux, which is weighted based on how sensitive the human eye is to various light wavelengths, measures the total radiant power released by the luminaire. [1]

Luminance

At a point along a beam's course, at a location on the surface of the source or receptor, or in a certain direction.

Quotient of the light flux leaving, reaching, or passing through a surface element at this point and propagating in a direction defined by an elementary cone containing the specified direction plus the area of the cone's orthogonal projection on a plane perpendicular to the specified direction multiplied by the solid angle of the cone. [1]

Luminous Efficacy

The ratio of a lamp's luminous flux to its power consumption. This term, which is stated in lumens/circuit watt, is sometimes referred to be lamp circuit luminous efficacious when the power used by control gear is considered. [1]

Beam Angle:

The angle (in degrees) at which the luminous flux leaves the light source is indicated by the beam angle. It is the angle at which light intensity above 50% of the maximum (Full Width at Half Maximum) was measured by the gonio photometer.

On occasion, field angle and beam angle can be seen together in product specifications. The field angle is the range of observed light intensity greater than 10% of the maximum. The light beam forms a cone with a diameter that corresponds to the distance between the light source and the floor or lit surface. Size of the generated light cone in the room is directly related to the angle of the light beam. [2]

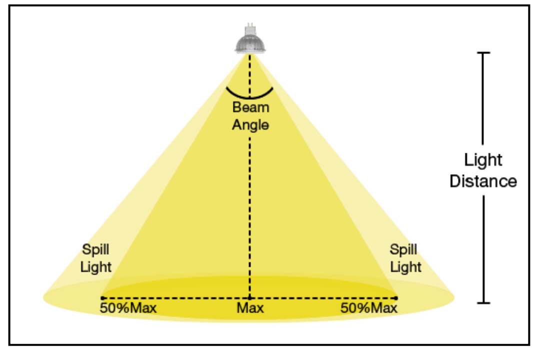


Fig:1.4a

Fig 1.4a shows the distribution of light and fig:1.4b & 1.4c shows the different Beam Angles.

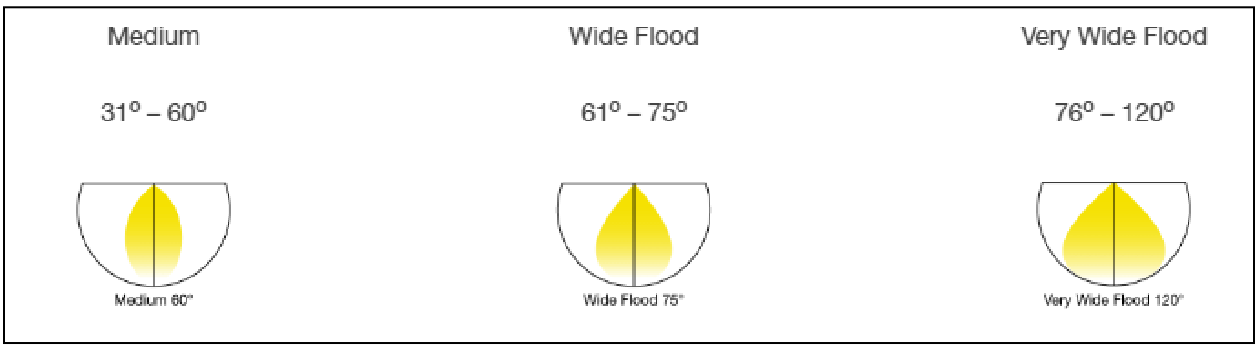


Fig:1.4b

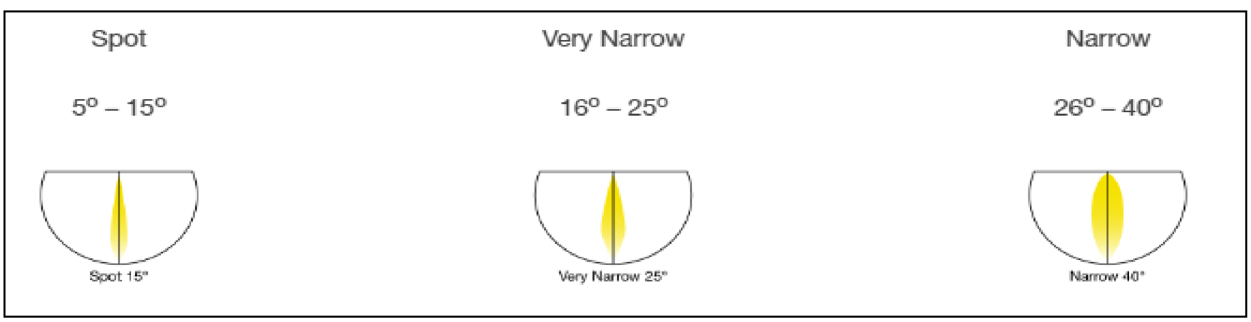


Fig:1.4c

Illuminance

At a surface point, the area of an element constitutes the quotient of the luminous, The flux incident on that element.

Glare

An inadequate distribution or range of brightness, or severe contrasts in space or time, might cause discomfort in the eyes or a loss in the capacity to perceive important objects, or both. [1]

CCT

A measure of the degree to which the colors of surfaces illuminated by a given light source confirm to those of the same surfaces under a reference illuminant. Suitable allowance having been made for the adaptation. [1]

Fig 1.5 shows different CCT values.

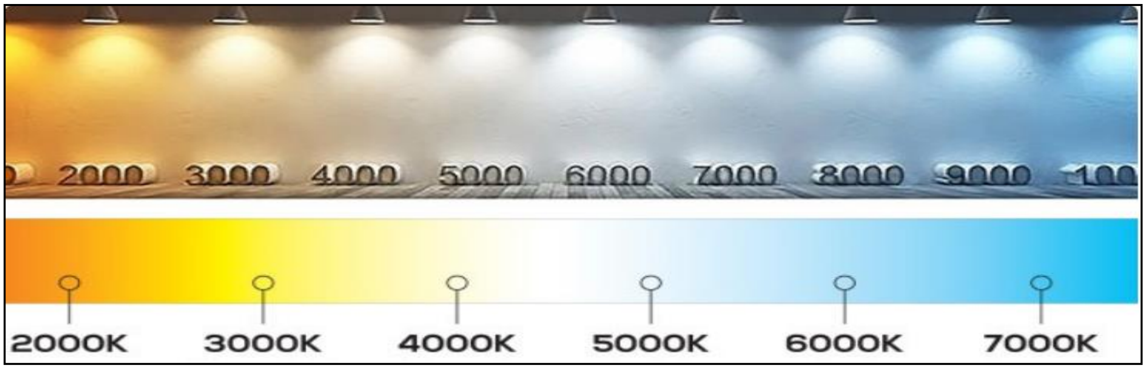


Fig:1.5

CRI

An inadequate distribution or range of brightness, or severe contrasts in space or time, might cause discomfort in the eyes or a loss in the capacity to perceive important objects, or both. [1]

Uniformity Ratio

the proportion of the lowest to average illumination. The ratio of the minimum illumination to the maximum illumination is given in certain cases. Typically, the ratio is applied to values over the working area on the working plane.

Surge Protection

Surge prevention mechanisms or circuits may be incorporated into LED luminaires to provide temporary overvoltage protection against voltage spikes. The longevity and dependability of the luminaire depend on surge protection, particularly in locations vulnerable to power surges or other electrical disruptions.

Comprehending the electrical characteristics of an LED luminaire is essential for appropriate installation, suitability with the electrical system, energy conservation, and guaranteeing adherence to electrical rules. [1]

IP Rating

A luminaire's level of protection against liquid and solid particle infiltration is indicated by its IP (Ingress Protection) rating. Two numbers make up the IP rating: the first indicates protection against solid particles, while the second indicates protection against liquids.

The European Standard [BS EN IEC: 60529, 2001] classifies the luminaire's level of protection based on its Ingress Protection code. A globally accepted technique for indicating the level of defense against dust, solid particles, and moisture seeping into an enclosure is the IP system which is shown in Table:1. [1]

Table:1

Level	Object Protected Against	Effective Against
0	Not protected	No protection against contact and ingress of objects
1	>50mm	Any large surface of the body, such as the back of the hand, but no protection against deliberate contact with a body part.
2	>12.5mm	Fingers or similar objects.
3	>2.5mm	Tools, thick wires, etc.
4	>1mm	Most wires, screws, etc.
5	Dust Protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact.
6	Dust Tight	No ingress of dust; complete protection against contact.

IK Rating

The resilience of a luminaire to shock or mechanical impacts is indicated by its IK (Impact Protection) rating. It gauges the luminaire's resistance to external mechanical forces and safeguards its internal parts. The IK rating, which represents various levels of impact resistance, is expressed as a numerical value between IK00 and IK10.

The energy level that each IK grade relates to establishes how resilient the luminaire is to shocks without losing its functioning or security. The IK ratings and the accompanying energy levels are broken down as follows:

• IK00: No impact protection. The luminaire offers no specific protection against mechanical impacts.

• IK01: Protection against impacts of 0.14 joules. This rating provides minimal protection against low-energy impacts, such as those caused by a small object accidentally hitting the luminaire.

• IK02: Protection against impacts of 0.2 joules. This rating offers slightly higher impact resistance compared to IK01.

•IK03: Protection against impacts of 0.35 joules. This rating provides moderate protection against medium-energy impacts.

•IK04: Protection against impacts of 0.5 joules. This rating offers increased impact resistance, suitable for environments where the luminaire may be exposed to stronger mechanical forces.

•IK05: Protection against impacts of 0.7 joules. This rating indicates a higher level of impact resistance, suitable for areas where there is a potential risk of stronger impacts or vandalism.

•IK06: Protection against impacts of 1 joule. This rating provides even higher13resistance against strong impacts, making the luminaire more robust.

•IK07: Protection against impacts of 2 joules. This rating indicates a higher level of impact resistance, suitable for environments with a higher risk of mechanical impact.

•IK08: Protection against impacts of 5 joules. This rating offers significantly higher impact resistance, making the luminaire highly durable and suitable for demanding applications.

•IK09: Protection against impacts of 10 joules. This rating provides excellent impact resistance, suitable for areas with a high risk of mechanical damage.

•IK10: Protection against impacts of 20 joules. This is the highest IK rating and indicates an extremely high level of impact resistance. Luminaires withIK10 rating can withstand severe mechanical impacts. [1]

5.Designing, Executing& Commissioning Conference & Office Room

Here using DIALux Evo the Conference Room and Office Room have been designed.

For Conference Room the average lux level is 800lux and for Office Room average lux level is 400lux.

The AutoCAD Drawing of the Conference Room is shown in Fig:5.1

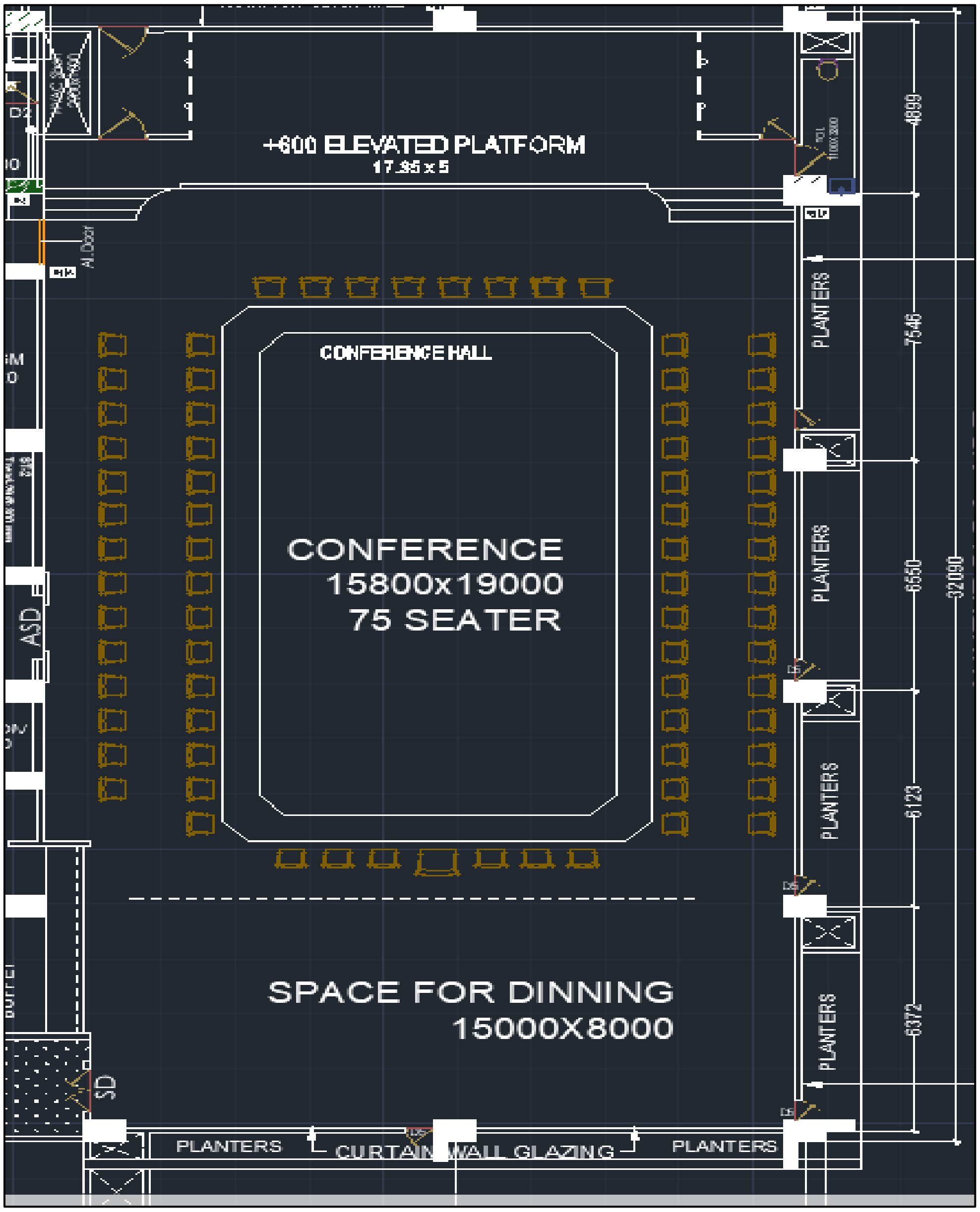


Fig:5.1

5.1AutoCAD Drawing of GM Office and Lobby:

Here is the AutoCAD design for of GM Office and Lobby, for design first import AutoCAD on DIALux evo then set the format of dimension. The AutoCAD Drawing of the Conference Room is shown in Fig:5.2

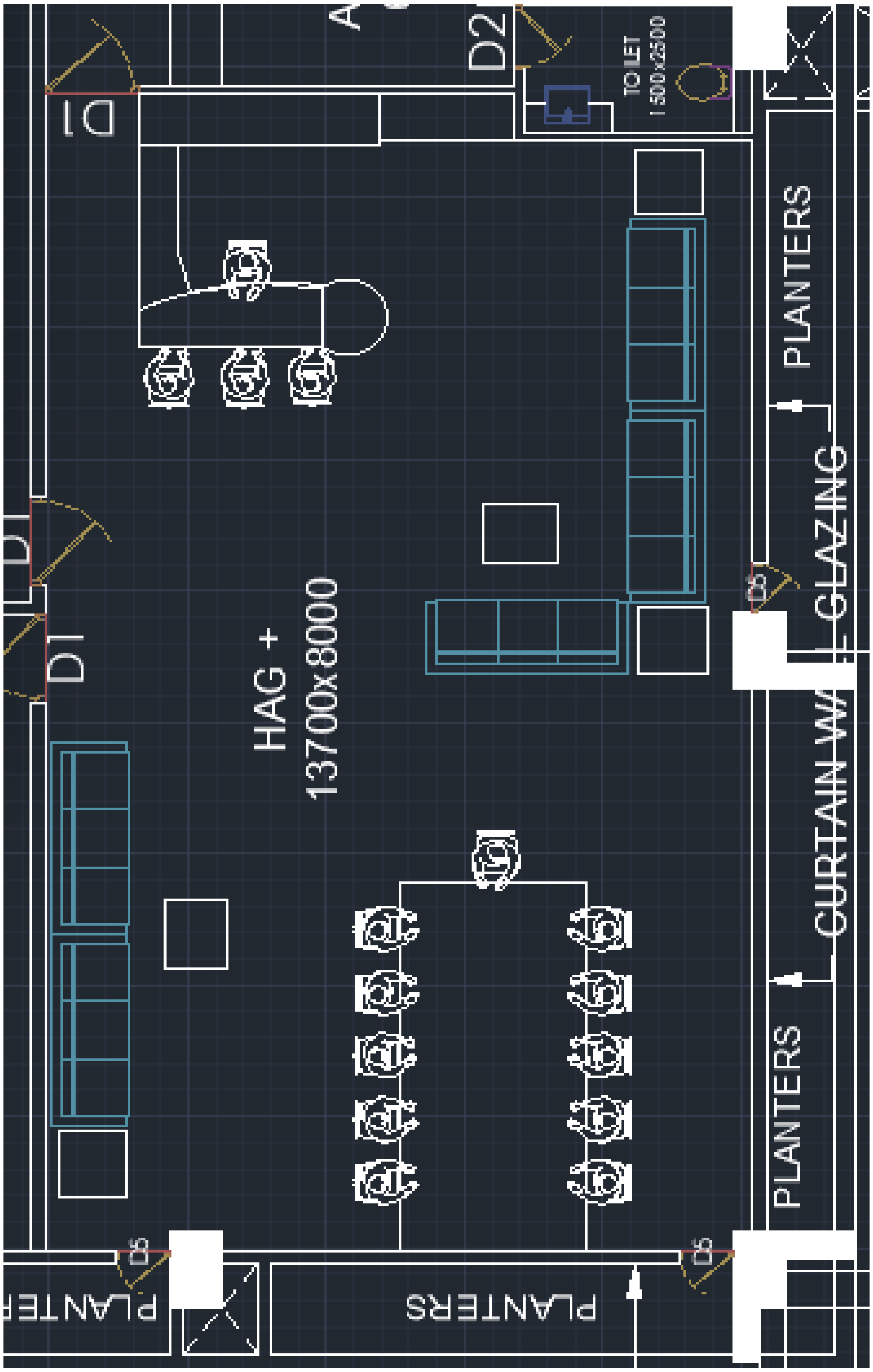


Fig:5.2

5.2AutoCAD Drawing of GM Lobby:

The drawing of the GM Lobby with the furniture layout and partitions has been shown in below fig:5.3.

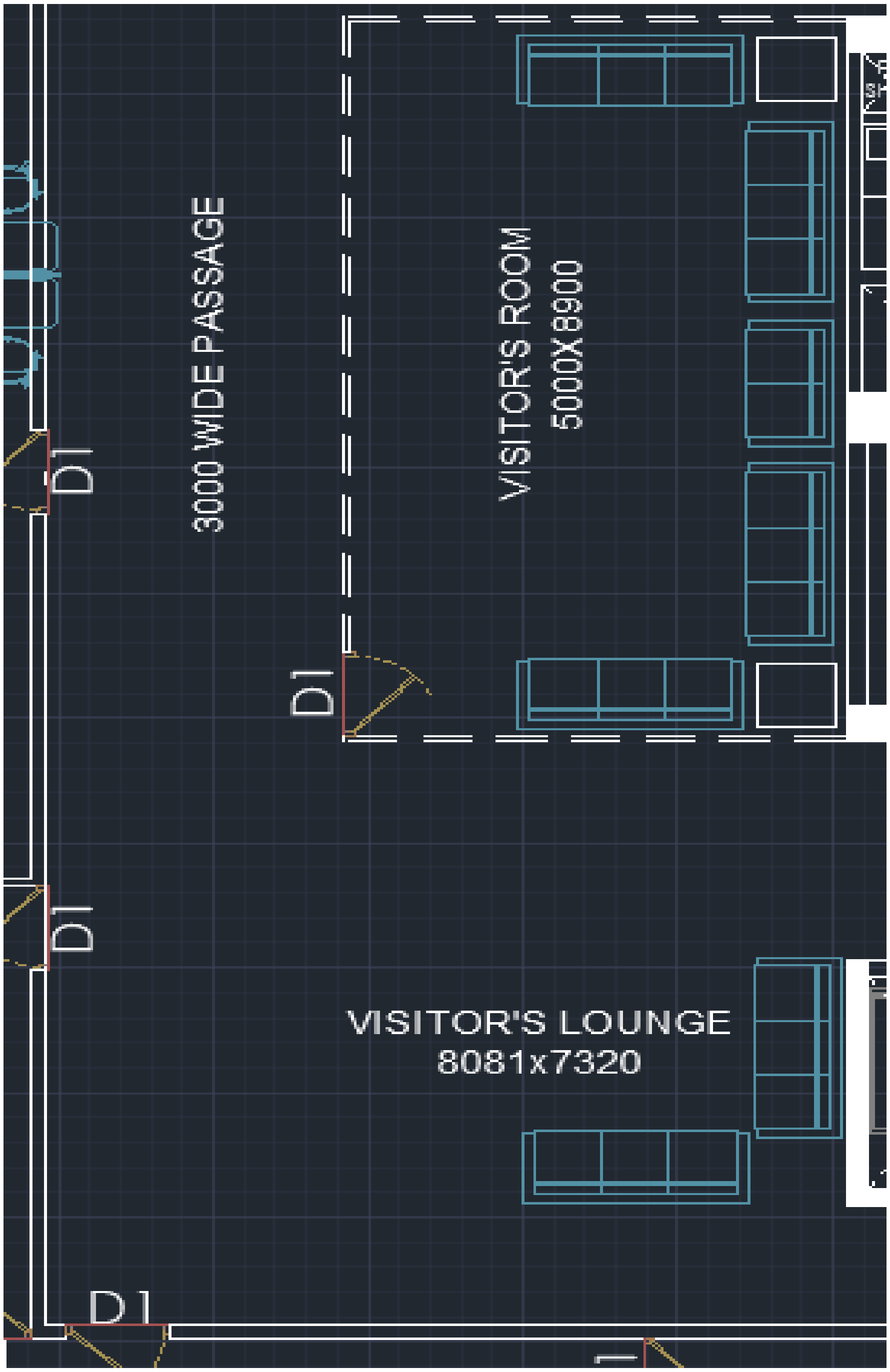


Fig:5.3

5.3Design Submitted to Client for Conference Room:

The 3D view of the Conference room with Furniture's positions has been shown in below fig:5.4 and fig:5.5.

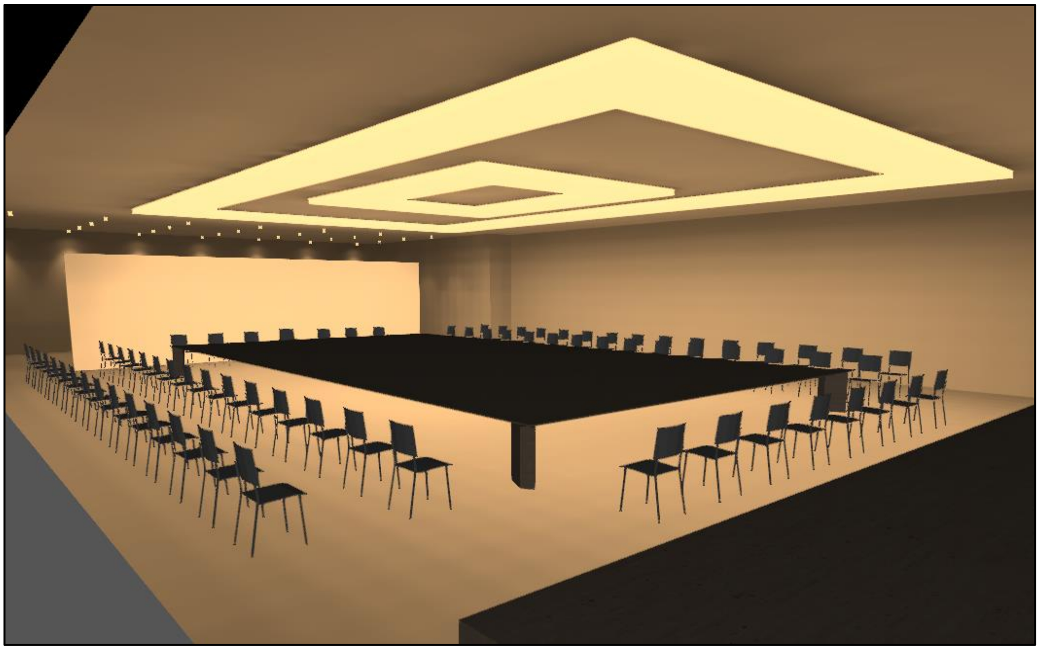


Fig:5.4

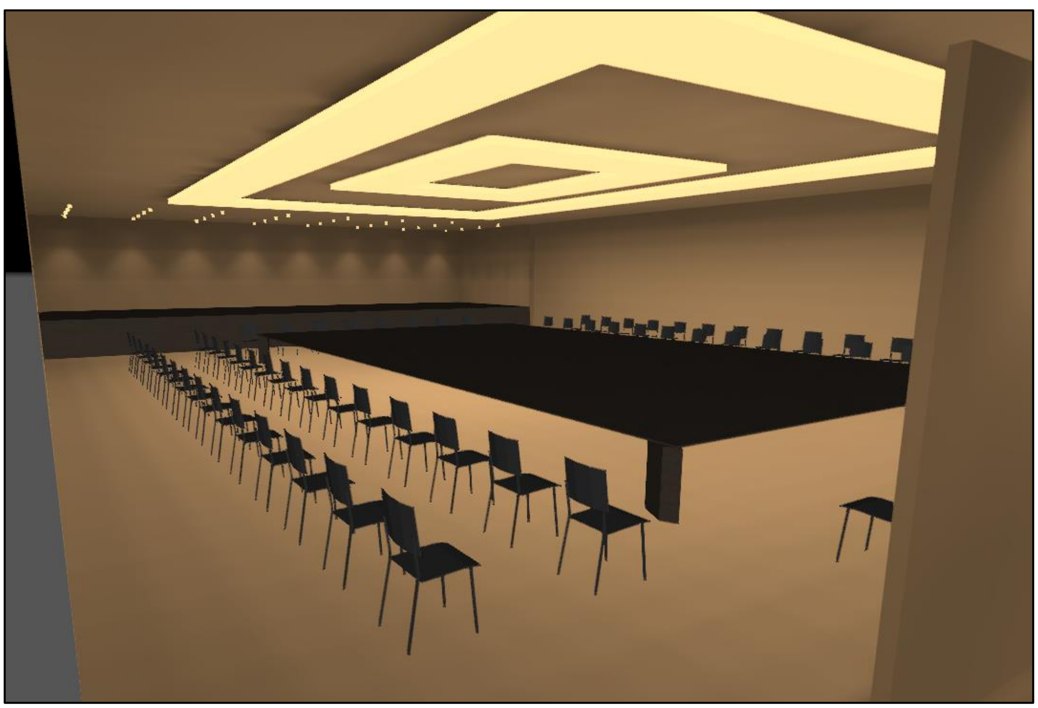


Fig:5.5

Here is the complete design report of the Conference room using DIALux evo software.

Using DIALux Evo for conference room average 650 lux has been achieved, where 50,30,20(Celling, Wall, Floor) is the reflectance of the room.

Table of Contents

Product data sheets

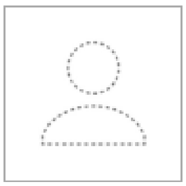
Site 1 - Building 1 - Storey 1

CONFERENCE ROOM

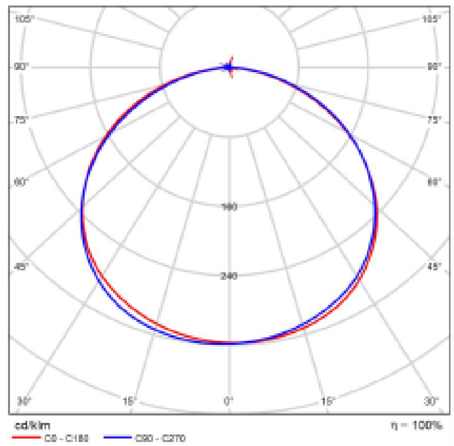
DIALux

Product data sheet

Not yet a DIALux member -



Article No.	LM98-801-XXX-40-WH
P	80.0 W
Φ_{Lamp}	5600 lm
$\Phi_{Luminaire}$	5600 lm
η	100.00 %
Luminous efficacy	70.0 lm/W
CCT	3000 K
CRI	100

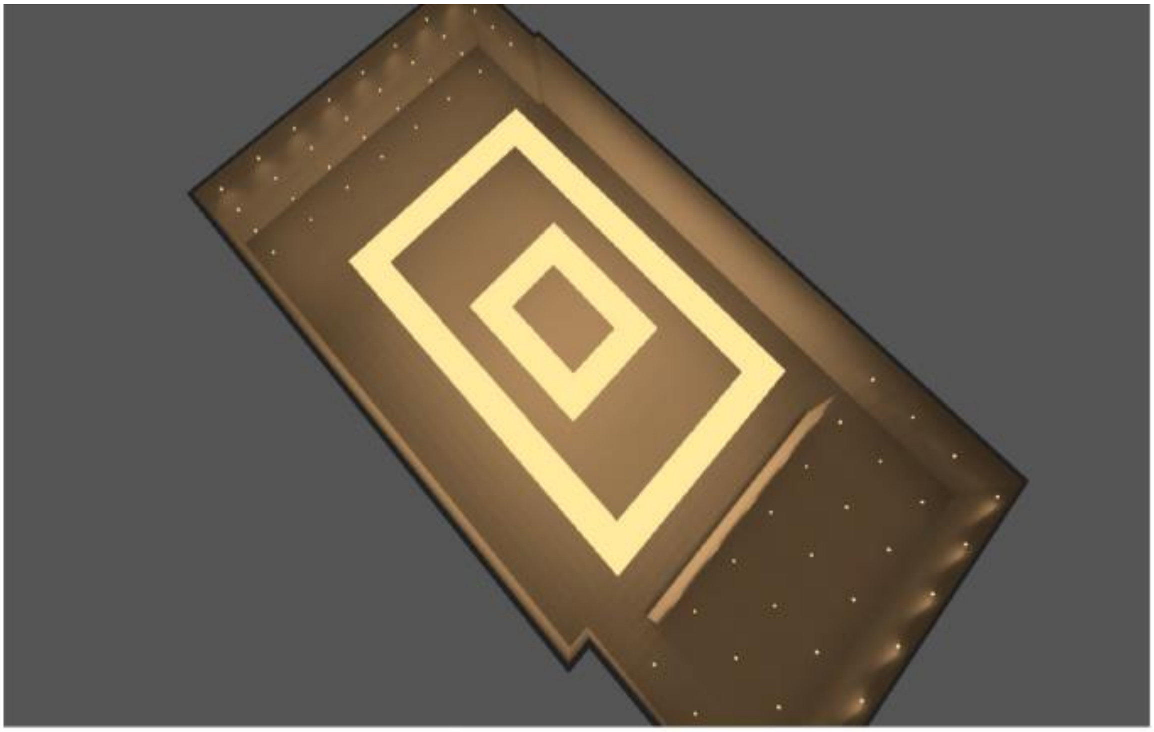


Polar LDC

Luminaire list

Φ_{total}	P_{total}	Luminous efficacy
348800 lm	4880.0 W	71.5 lm/W

pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy
60	Not yet a DIALux member	LD07-131-060-57-CH		12.0 W	960 lm	80.0 lm/W
52	Not yet a DIALux member	LM98-801-XXX-40-WH		80.0 W	5600 lm	70.0 lm/W



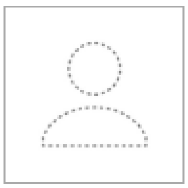
GM Building- NFR

DISCLAIMER: Calculations have been performed according to IESNA & CIE standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

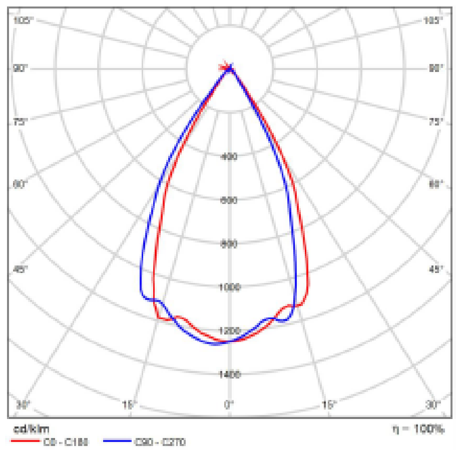
DIALux

Product data sheet

Not yet a DIALux member -



Article No.	LD07-131-060-57-CH
P	12.0 W
Φ_{Lamp}	960 lm
$\Phi_{Luminaire}$	960 lm
η	99.98 %
Luminous efficacy	80.0 lm/W
CCT	3000 K
CRI	100



Polar LDC

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1)

Summary

Results

	Symbol	Calculated	Index
Working plane	$E_{perpendicular}$	633 lx	WP1
	U_o (g_1)	0.27	WP1
	Lighting power density	11.76 W/m²	
		1.86 W/m²/100 lx	
Energy estimation[2]	Consumption	805 kWh/a	
Room	Lighting power density	10.00 W/m²	
		1.58 W/m²/100 lx	

(1) Based on a rectangular space of 31.340 m x 15.862 m and SHR of 0.25.
(2) Calculated using DIN:18599-4.

Utilisation profile: General areas inside buildings - Control rooms (5.3.1 Plant rooms, switchgear rooms)

Luminaire list

pcs.	Manufacturer	Article No.	Article name	R_{UG}	P	Φ	Luminous efficacy
60	Not yet a DIALux member	LD07-131-060-57-CH		–	12.0 W	960 lm	80.0 lm/W
52	Not yet a DIALux member	LM98-801-XXX-40-WH		–	80.0 W	5600 lm	70.0 lm/W

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1)

Summary

Results

	Symbol	Calculated	Index
Working plane	$\bar{E}_{perpendicular}$	655 lx	WP1
	U_o (g_1)	0.27	WP1
	Lighting power density	11.76 W/m²	
		1.80 W/m²/100 lx	
Energy estimation[2]	Consumption	805 kWh/a	
Room	Lighting power density	10.00 W/m²	
		1.53 W/m²/100 lx	

(1) Based on a rectangular space of 31.340 m x 15.862 m and SHR of 0.25.
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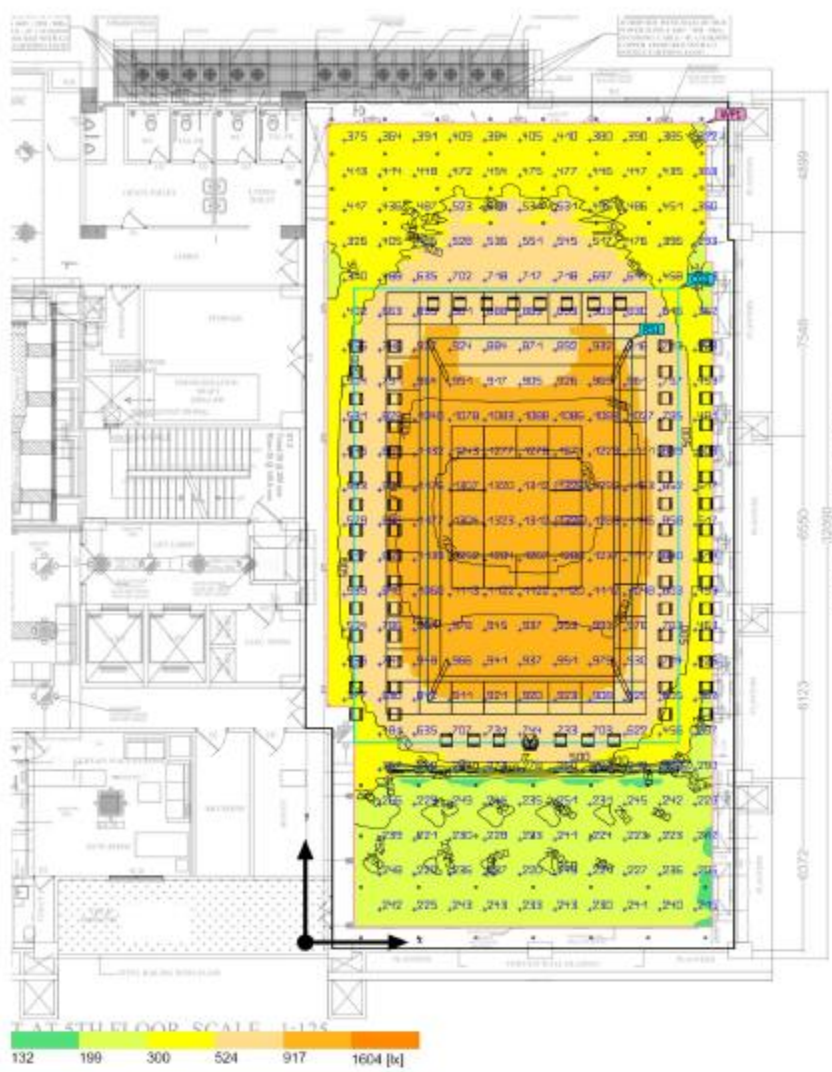
52	Not yet a DIALux member	LM98-801-XXX-40-WH		-	80.0 W	5600 lm	70.0 lm/W

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1)

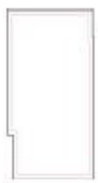
Summary

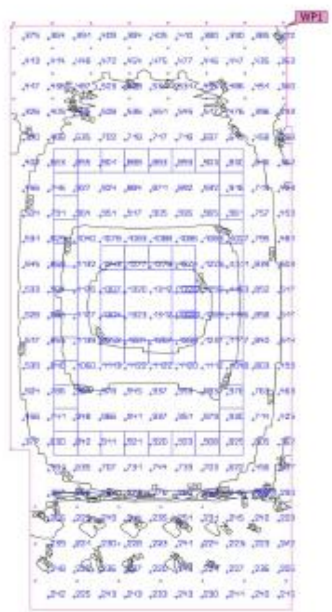


Ground area	487.82 m²
Reflection factors	Ceiling: 50.0 %, Walls: 30.0 %, Floor: 20.0 %
Maintenance factor	0.85 (fixed)

Clearance height	4.000 m
Mounting height	4.000 m
Height $_{\text{Working plane}}$	0.800 m
Wall zone $_{\text{Working plane}}$	0.800 m

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1) **(CONFERENCE ROOM)**



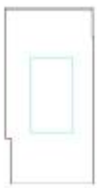


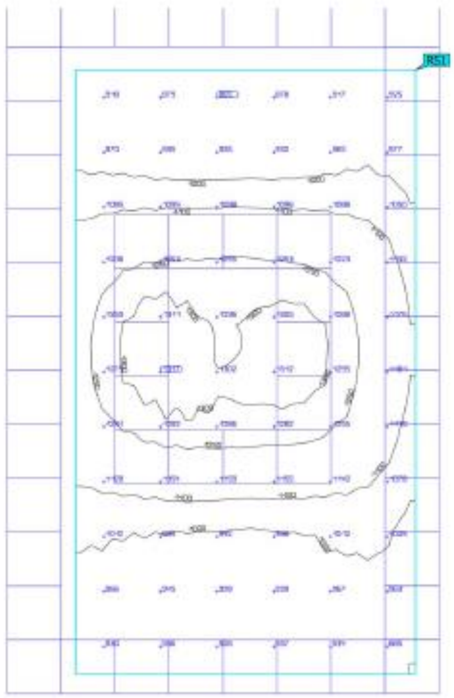
Properties	Ē	E_{min}	E_{max}	U_o (g_1)	g_2	Index
(CONFERENCE ROOM) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.800 m	655 lx	180 lx	1334 lx	0.27	0.13	WP1

Utilisation profile: General areas inside buildings - Control rooms (5.3.1 Plant rooms, switchgear rooms)

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1)

Conference Table





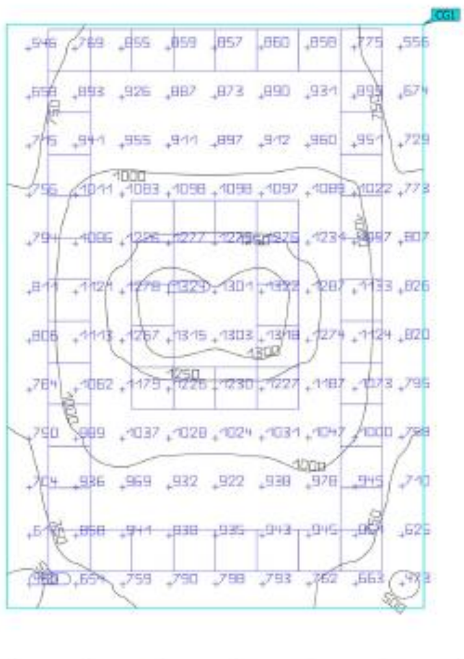
Properties	Ē	E_{min}	E_{max}	U_o (g_1)	g_2	Index
Conference Table Perpendicular illuminance (adaptive) Height: 0.720 m	1087 lx	798 lx	1319 lx	0.73	0.61	RS1

Utilisation profile: General areas inside buildings - Control rooms (5.3.1 Plant rooms, switchgear rooms)

DIALux

Site 1 · Building 1 · Storey 1 · CONFERENCE ROOM (Light scene 1)

Conference Area



Properties	Ē	E_{min}	E_{max}	U_o (g_1)	g_2	Index
Conference Area Perpendicular illuminance Height: 0.800 m	950 lx	460 lx	1324 lx	0.48	0.35	CG1

Utilisation profile: General areas inside buildings - Control rooms (5.3.1 Plant rooms, switchgear rooms)

During installation using anchor bolt wires has been hanged from true celling.

5.4 Execution:

During Installation of the fitting,as a member of the team helping with design parameters as main task to do. In Fig:5.4.a and Fig:5.4.b shows how anchor fastener has been connected to true celling .

Fig:5.4.a

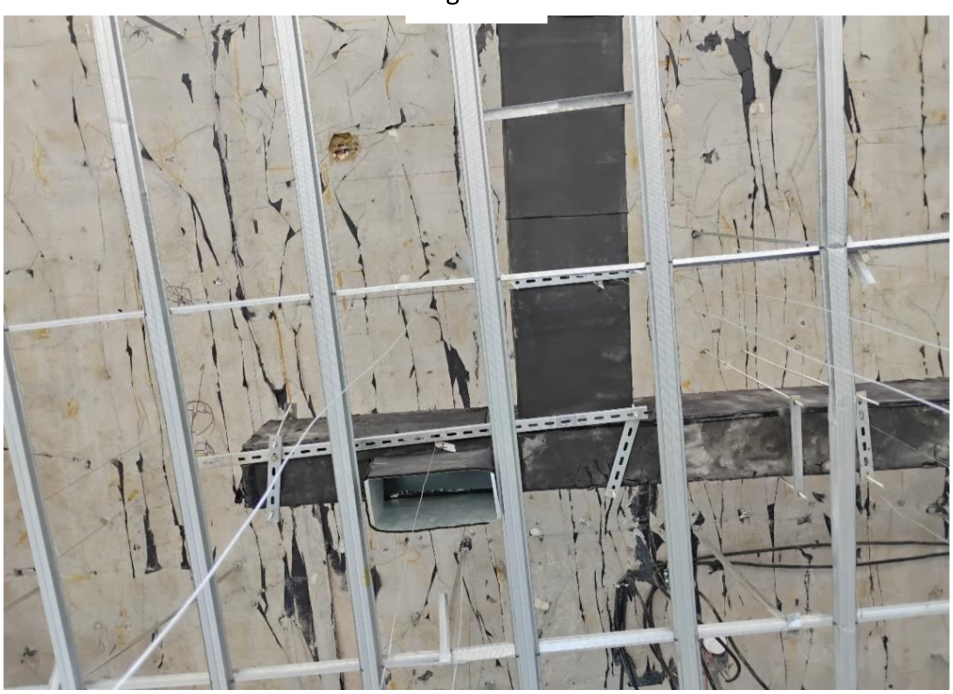


Fig:5.4.b

Fig:5.4.c and Fig:5.4.d shows how luminaires are hanging from the suspensions.

Fig:5.4.c

Fig:5.4.d

Complete luminaires connected with suspension. After installation carefully the fittings have been adjusted upward .Comlete Luminaire has been shown in Fig:5.4.e.

Fig:5.4.e

Fig:5.4.f and Fig:5.4.g shows that complete sky scale has installed with the drivers.

Fig:5.4.f

Fig:5.4.g

Attaching Fabric with The Luminaire after Complete installation. In Fig:5.4.g complete fitting is without diffuser and Fig:5.4.h shows how diffuser is being installed.

Fig:5.4.h

Fig:5.4.i

Fig:5.4.j shows complete fitting after installing the diffuser completely. DALI dimming has been provided with this fitting so, the client can dim the fitting at ease from remote and application.

Fig:5.4.j

5.5 Connecting The Controller with LED driver:

From live and neutral supply will be given to the controller and to the driver. And from controller DALI1 & DALI2 two wires will be connected to every driver simultaneously as shown below Fig:5.5.a

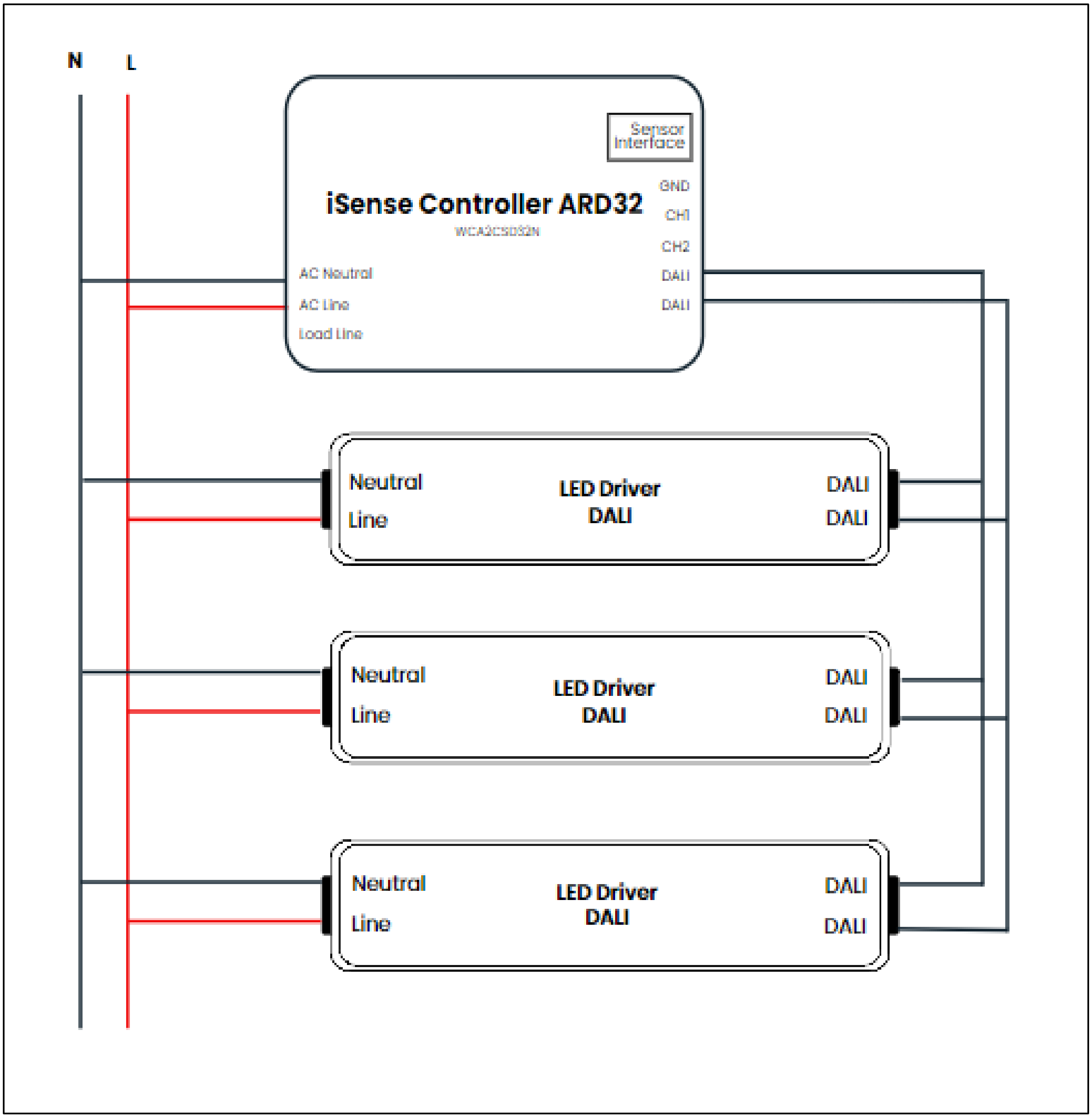


Fig:5.5.a

5.6 GM office design submitted to the client:

3D view of the office has been shown below fig:5.6.a and 5.6.b.In office room two skyscale and 32 hexagonal fitting has been used.

Fig:5.6.a

Fig:5.6.b

DESIGN REPORT OF OFFICE ROOM:

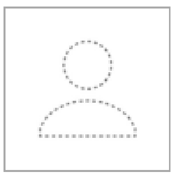
Using DIALux Evo the office room has been designed with average lux level 450 lux ,where uniformity is 0.4 and reflectance factor is 50,30,20(celling,wall,floor).

GM Building- NFR

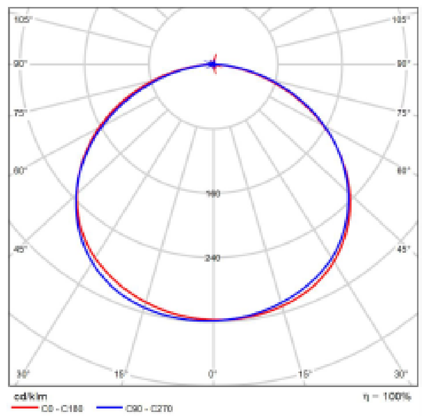
DIALux

Product data sheet

Not yet a DIALux member -



Article No.	LM98-801-XXX-40-WH
P	80.0 W
Φ_{Lamp}	5600 lm
$\Phi_{Luminaire}$	5600 lm
η	100.00 %
Luminous efficacy	70.0 lm/W
CCT	3000 K
CRI	100



Polar LDC

DIALux

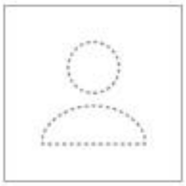
Luminaire list

Φ_{total}	P_{total}	Luminous efficacy
104950 lm	1390.0 W	75.5 lm/W

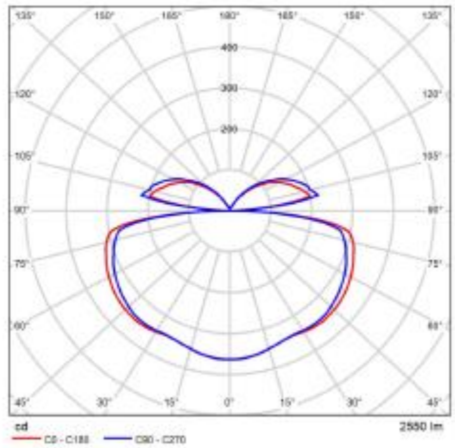
pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy
17	Not yet a DIALux member	LM13S-451-XXX-57WC	LM13S-451-XXX-57WC	30.0 W	2550 lm	85.0 lm/W
11	Not yet a DIALux member	LM98-801-XXX-40-WH		80.0 W	5600 lm	70.0 lm/W

Product data sheet

Not yet a DIALux member - LM13S-451-XXX-57WC



Article No.	LM13S-451-XXX-57WC
P	30.0 W
$\Phi_{Luminaire}$	2550 lm
Luminous efficacy	85.0 lm/W
CCT	3000 K
CRI	100



Polar LDC

Glare evaluation according to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	8.8	11.0	10.4	11.7	12.9	9.6	10.8	10.2	11.8	12.2
	3H	12.9	14.0	13.5	14.6	15.4	12.6	13.7	13.2	14.3	15.1
	4H	14.5	15.6	15.2	16.3	17.1	14.2	15.2	14.9	15.9	16.7
	6H	16.3	17.3	17.0	18.0	18.8	15.9	16.9	16.6	17.6	18.5
	8H	17.2	18.2	17.9	18.9	19.7	16.8	17.7	17.6	18.4	19.3
	12H	17.9	18.8	18.6	19.6	20.4	17.5	18.4	18.2	19.1	19.9
4H	2H	10.9	11.9	11.6	12.6	13.4	10.7	11.8	11.4	12.8	13.3
	3H	14.1	15.0	14.8	15.7	16.6	13.8	14.7	14.6	15.5	16.3
	4H	15.9	16.7	16.6	17.4	18.3	15.6	16.4	16.3	17.2	18.0
	6H	17.8	18.5	18.6	19.3	20.2	17.5	18.2	18.2	18.9	19.9
	8H	18.8	19.4	19.5	20.2	21.1	18.4	18.8	19.1	19.8	20.7
	12H	19.6	20.2	20.3	21.0	21.9	19.1	19.7	19.9	20.6	21.6
8H	4H	16.5	17.2	17.3	18.0	18.9	16.3	17.0	17.1	17.8	18.7
	6H	18.7	19.3	19.5	20.1	21.0	18.4	19.0	19.2	19.8	20.7
	8H	19.8	20.3	20.6	21.1	22.1	19.4	19.9	20.2	20.8	21.7
	12H	20.7	21.1	21.5	22.0	23.0	20.3	20.7	21.1	21.6	22.6
12H	4H	16.7	17.3	17.5	18.1	19.0	16.5	17.1	17.3	17.9	18.8
	6H	18.9	19.4	19.7	20.2	21.2	18.6	19.1	19.5	20.0	20.9
	8H	20.1	20.6	20.9	21.3	22.3	19.8	20.2	20.6	21.8	22.0
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.2				
S = 2.0H		+0.3 / -0.4					+0.3 / -0.4				
Standard table		BK12					BK12				
Correction summand		4.6					4.3				
Corrected glare indices referring to 2550lm Total luminous flux											

UGR diagram (SHR: 0.25)

Building 1 · Storey 1 · GM CHAMBER (Light scene 1)

Summary

Results

	Symbol	Calculated	Index
Working plane	$\bar{E}_{perpendicular}$	491 lx	WP1
	U_o (g_1)	0.40	WP1
	Lighting power density	18.68 W/m²	
		3.80 W/m²/100 lx	
Glare valuation[1]	$R_{UG, max}$	15	
Energy estimation[2]	Consumption	229 kWh/a	
Room	Lighting power density	13.14 W/m²	
		2.68 W/m²/100 lx	

(1) Based on a rectangular space of 13.212 m x 8.007 m and SHR of 0.25.
(2) Calculated using DIN:18599-4.

Utilisation profile: General areas inside buildings - Control rooms (5.3.1 Plant rooms, switchgear rooms)

Luminaire list

pcs.	Manufacturer	Article No.	Article name	R_{UG}	P	Φ	Luminous efficacy
17	Not yet a DIALux member	LM13S-451-XXX-57WC	LM13S-451-XXX-57WC	15	30.0 W	2550 lm	85.0 lm/W
11	Not yet a DIALux member	LM98-801-XXX-40-WH		-	80.0 W	5600 lm	70.0 lm/W

5.7 Execution of Office:

Similarly to conference room suspension has been hanged from the ceiling as shown in the below fig:5.7.a and fig 5.7.b.

Fig:5.7.a

Fig:5.7.a

Fig:5.7.c and Fig:5.7.d shows how hexagonal 16 skymesh installed in the office.

Fig:5.7.c

Fig:5.7.d

Fig:5.7.e and Fig:5.7.f shows complete installation of two sky scale with diffuser. Suspension has been also in proper height(1 ft from false ceiling).

Fig:5.7.e

Fig:5.7.f

Now some images taken during inauguration (Conference Room):

Fig:5.7.g and fig:5.7.h shows images taken during inauguration day of conference room.

Fig:5.7.g

Fig:5.7.h

Lobby:

Fig:5.7.i and fig:5.7.j shows images taken during inauguration day of lobby.

Fig:5.7.i

Fig:5.7.j

Office

Fig:5.7.k and fig:5.7.l shows images taken during inauguration day of Office.

Fig:5.7.k

Fig:5.7.l

6.DALI (Digital Addressable Lighting Interface)

DALI (Digital Addressable Lighting Interface) is a data protocol and transport mechanism that was jointly developed and specified by several manufacturers of lighting equipment. The common platform of DALI enables equipment from different manufacturers to be connected together.[10]

What DALI can do for us

• Facilitate the easy integration of equipment from different vendors

• Reduce installation costs

• Offer a finer granularity of control for a given price

What DALI will NOT do

• Remove the need for a data cable to connect fixtures

• Lower commissioning & programming times

• Save the maximum possible amount of energy (unless extra equipment is used as described below)

• Remove the need for a backbone running a high-level protocol in larger sites.

6.1 Controller Used with DALI:

In this project two types of devices used, Controller and Wall Switch.

Controller:

ARD32 and AF10 Controller has been used in this project.

- ARD32: The device can be controlled as 0-10V or DALI, and it can be connected to a maximum of 32 DALI LED drivers. It may be set up in 0-10V mode to control voltage between 0 and 277 VAC. It operates within this voltage range.

  A tuneable white LED driver with two 0-10V control interfaces, or one or two controlled LED drivers with a voltage range of 0-10V. A 3.3VDC input channel that is included with this device can be utilized to interface with an external sensor. It contains an input for an external AC relay and a programmable communication interface for status and control.[10]

  Fig 6.1.a shows the images of ARD32 Controller.

  - ❖ FEATURES of ARD32 controller:
    - DALI supporting up to 32 child devices
    - Optional analog 2 channel (0-10V) independent output to
    - control intensity and CCT
    - Zero downtime Over-the-Air (OTA) firmware updates

Fig:6.1.a

- AF10: iSense Controller AF10, the dual-channel dimming/ tuneable AC fixture controller is a part of the Wipro iSense ecosystem. The device is easy to mount in an electrical junction box or compatible fixtures. The device has dual channel 0-10V independent output to control intensity and correlated color temperature (CCT) and it has a 0-3VDC input channel and 12VDC aux output to integrate with third-party sensors. The device with a 3A relay for load control saves time designing an intelligent lighting network that is in tune with your circadian rhythm. It can be quickly commissioned, configured, and controlled from any mobile device and can be connected to IoL cloud for data analytics and configuration management.

  Fig 6.1.b shows AF10 controller.

  FEATURES of AF10 controller:

  - Dual channel 0-10V independent output to control intensity
  - and correlated color temperature (CCT)
  - Auxiliary 12V/200mA output to power sensors
  - 0-3VDC input channel to integrate with third party sensors
  - 3A relay for turning ON/OFF DIM to 1 driver
  - Standard ½ inch chase nipple allows easy mounting to a
  - junction box or compatible fixture
  - Zero downtime Over-the-Air (OTA) firmware updates.[10]

Fig:6.1.b

Wall Switch:

iSense Wall Switch V is a battery-powered switch that controls ON/OFF, intensity, and Correlated Color Temperature of an individual or group of luminaires. This five-button switch device operates on a 3V coin cell battery and is designed for maximum longevity. Fig:6.1.c shows image of Wall Switch.

Features:

- Controls ON/OFF, intensity, and CCT of an individual or a group of luminaires.
- BLE4.2 based non-flooding intelligent communication.
- Easy installation with a wall bracket and a magnet attached back of the remote.

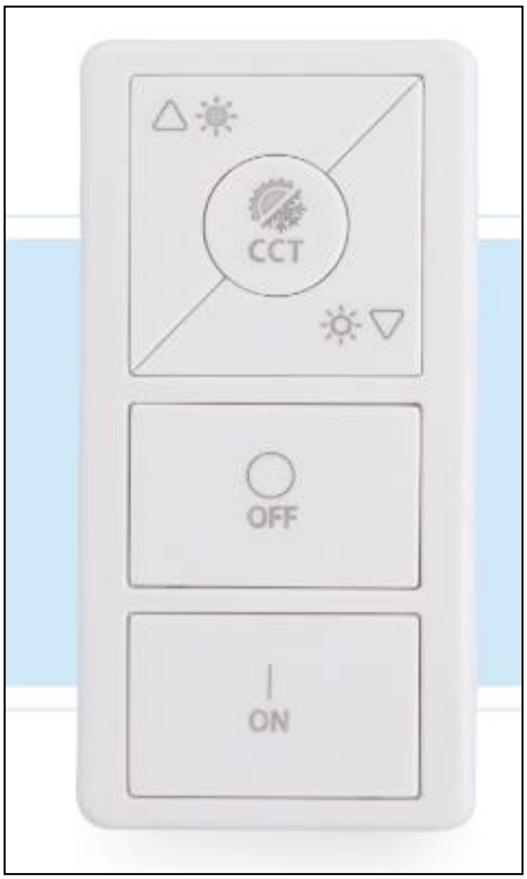


Fig:6.1.c

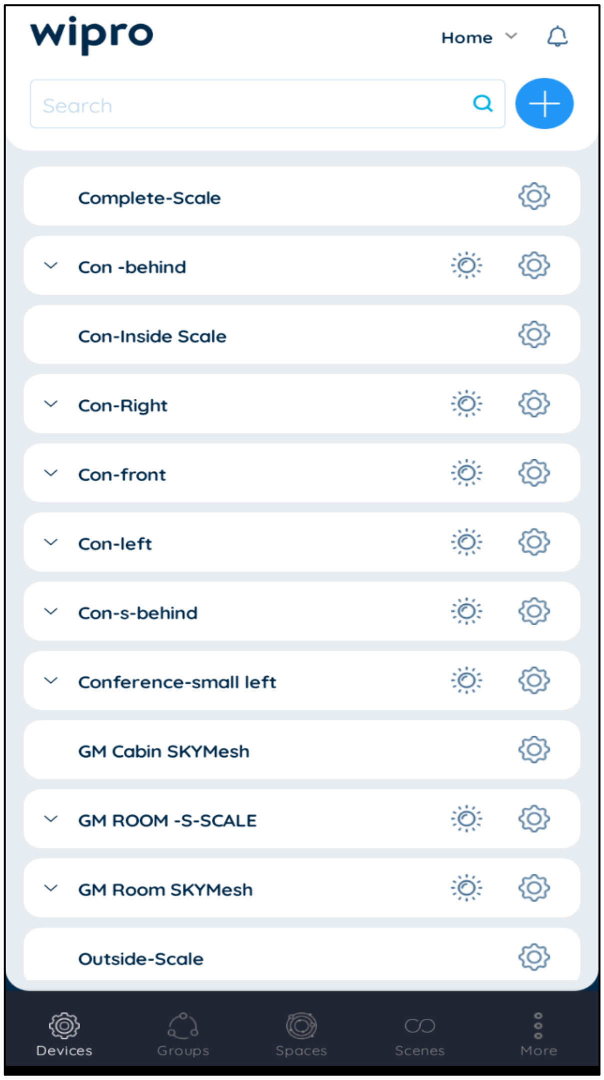
6.2 DALI Commissioning:

Using Wipro IOL App Dali Drivers has been commissioned with luminaires.

Fig:6.1.d and fig:6.1.e shows how to commission DALI drivers with luminaires from application.

Steps for commissioning:

- Using password log in to the app.
- Now tap on add device.
- All drivers will be shown here.
- Now sync and group the drivers.
- Now Wall switch and connect with groups.



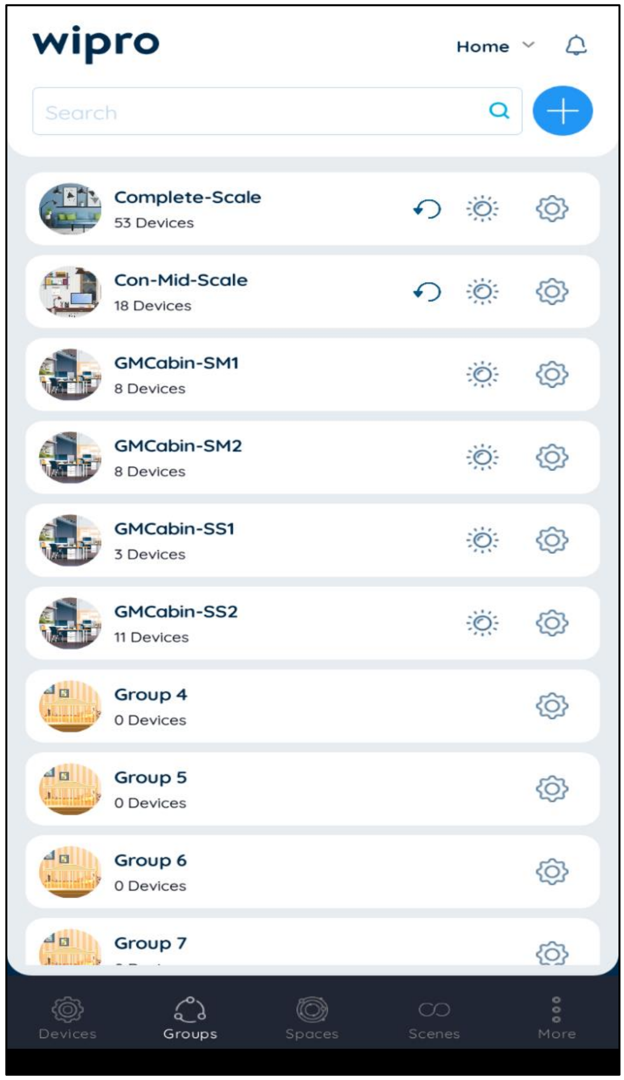


Fig:6.1.d

Fig:6.1.e

Fig:6.1.f and fig:6.1.g shows individual DALI drivers and how to control from app like ON/OFF and Intensity.

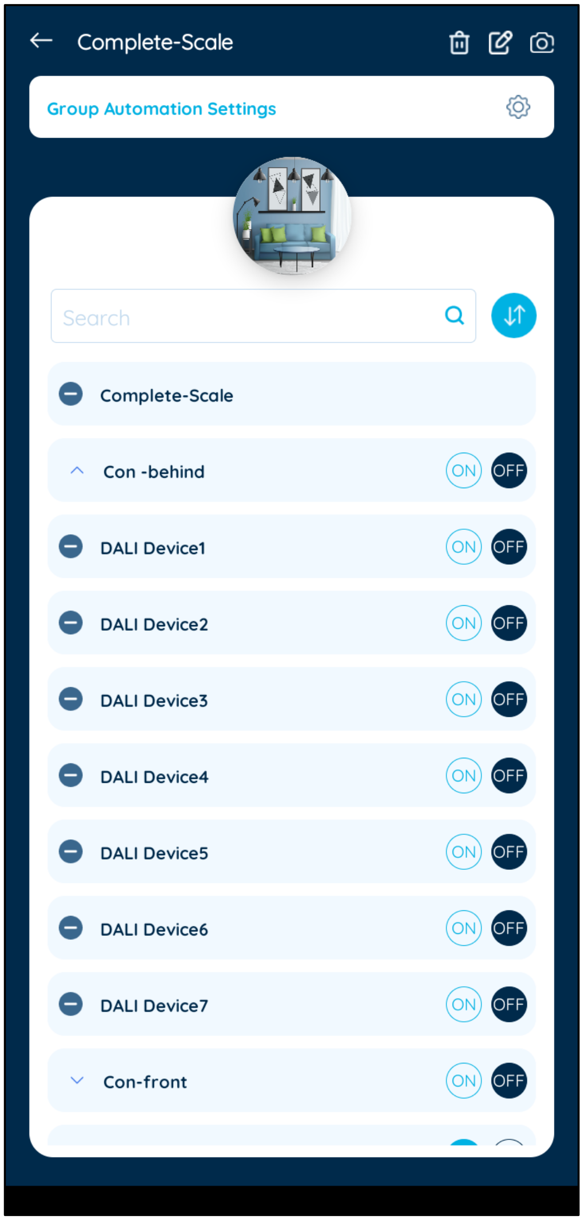


Fig:6.1.f

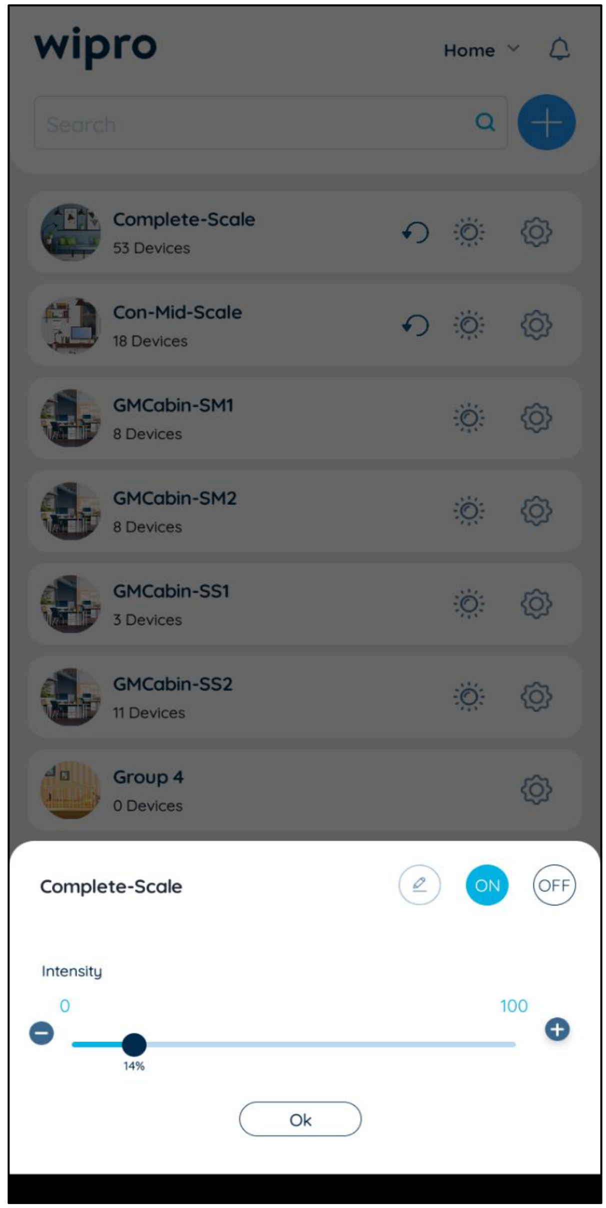


Fig:6.1.g

Façade Design:

The principal front or the outside facing sides of the structure are commonly referred to as the facades. They are among the most significant external design components in architecture since they greatly influence the entire atmosphere of the building. Additionally, they are essential to a building's energy efficiency, acoustic performance, and light transmittance.

The attainment of higher aesthetics is influenced by facades, which is where facade lighting is relevant. Adding lighting to a building's front can make it stand out from the crowd by highlighting the architecture and emphasizing important architectural details.

Experts claim that tastefully lit buildings draw attention to themselves and improve the surrounding area. An excellent first impression of the building is created by appropriate façade lighting, which significantly draws in consumers and staff.

Purpose:

The primary purpose of thoughtfully designed exterior lighting is to draw attention to the building's key elements. Additionally, it can be used to give the exteriors a creative vibe by using shadows. The leading makers of commercial lighting claim that while silhouetting yields completely diverse effects, emphasizing a feature increases its visibility.

Types Of Façades:

- **Solid facades**: A smooth, texturally-free wall surface is referred to as a solid facade. The main factor affecting these facades is natural illumination, or sunlight. On the other hand, distinct light patterns and a distinct structure can be applied to huge, homogenous surfaces.
- **Vertically divided facades**: To accentuate the vertical division, developers can incorporate thin light beams. To enhance the facade, they may also think about combining up lights and downlights.
- **Facades with horizontal divides**: These divisions can give the facade of the building lengthy, dark shadows. Nonetheless, this can be lessened by increasing the luminaire's offset from the facade.
- **Perforated facades**: An inventive façade that enables imaginative application of various lighting techniques. For example, users can use Linear Wall Washer LED to illuminate these captivating covers.

7.1 Design Submitted to The Client:

Using DIALux evo the building has been designed and 10 scenes has been submitted to client. Submitted scenes has been shown below figures.

Fig:7.1. a and 7.1.b shows multicolor and tricolor scene.

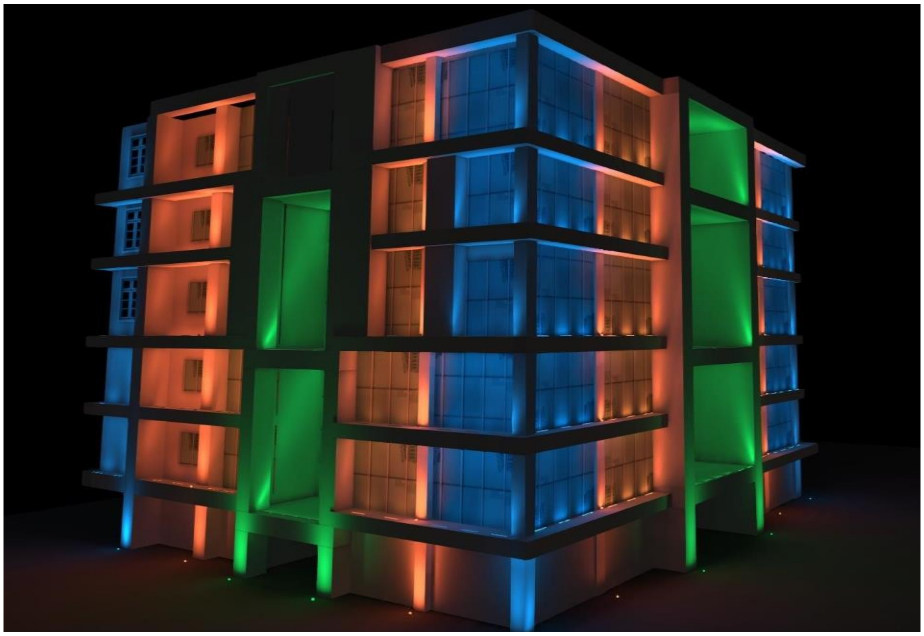


Fig:7.1.a

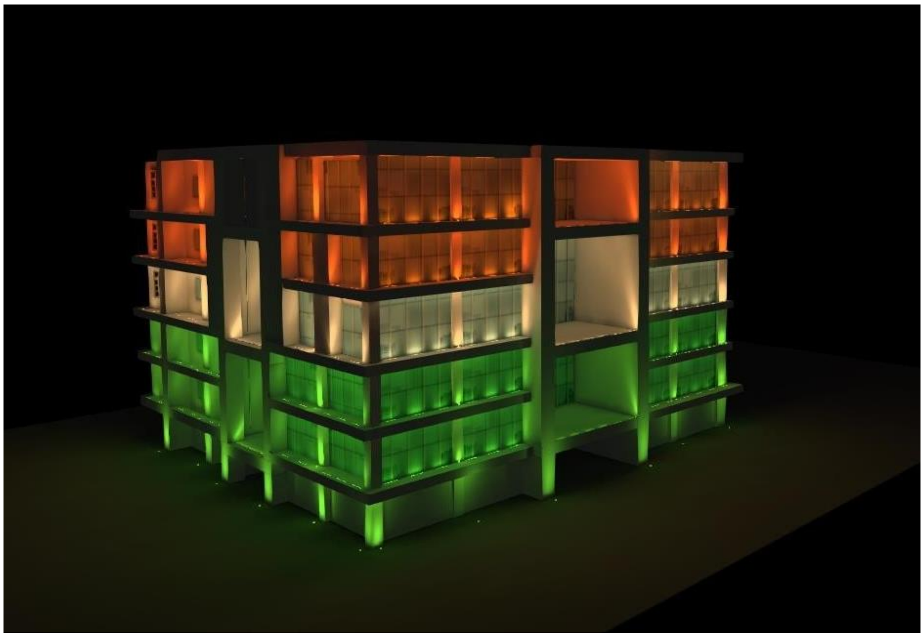


Fig:7.1.b

Fig:7.1.c and Fig:7.1.d shows tricolor and saffron on below scenes.

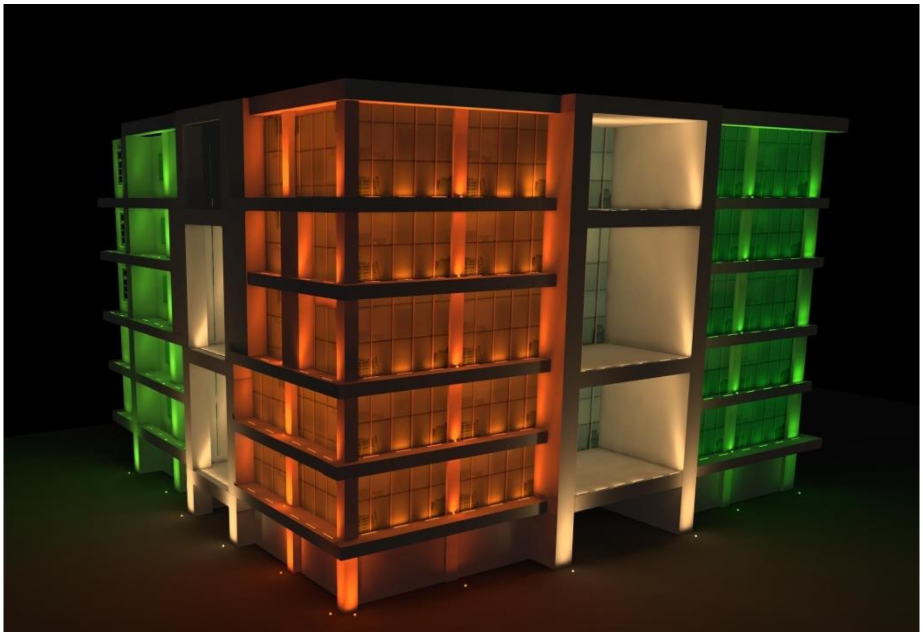


Fig:7.1.c

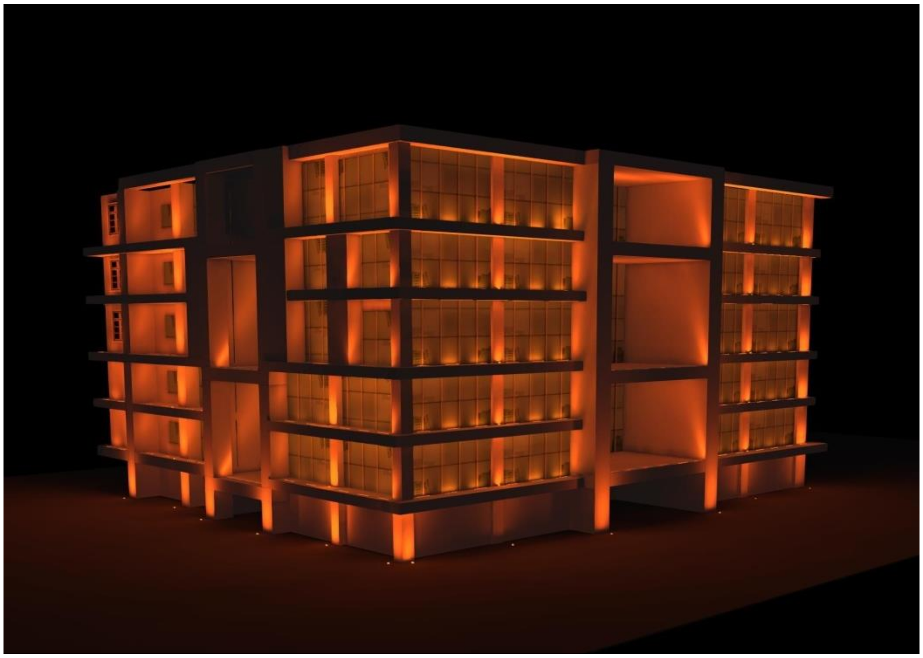


Fig:7.1.d

Fig:7.1.e ,Fig:7.1.f and Fig:7.1.f shows green, magenta and warm white on below scenes.

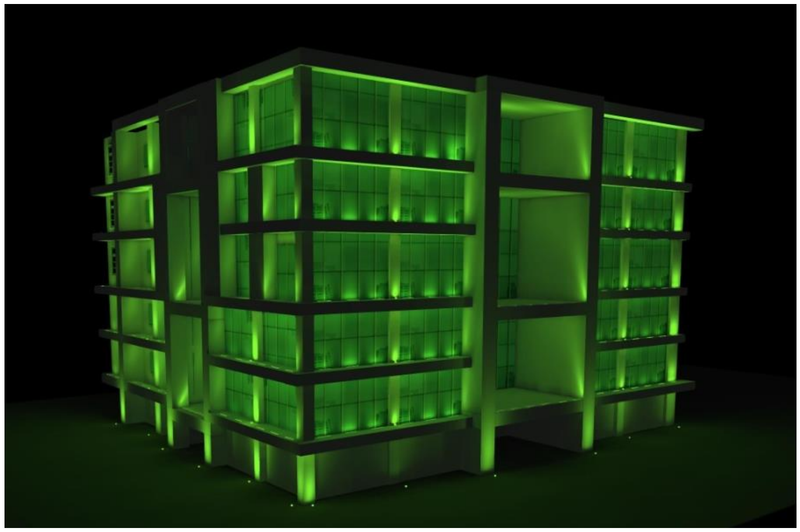


Fig:7.1.e

Fig:7.1.f

Fig:7.1.g

Fig:7.1.h ,Fig:7.1.i and Fig:7.1.j shows two multi color and violet on below scenes.

Fig:7.1.h

Fig:7.1.i

Fig:7.1.i

7.2Site Inspection:

- During site inspection our team has been found out that ground floor has no scope for luminaries mounting.
- The building is also having most glass part on every floor.
- After discussion with client our team decided to conceal wiring that does not effect on building overall look.
- Then we pointed out power source for splitter, DMX Controller.
- Now as per discussion with we installed our splitter and DMX controller.

We have used these products as per our design specification shown in Table:2.

Table:2

SL No	Product	Qty
1	24W RGBW Floodlight	28
2	72W RGBW Floodlight	2
3	24W RGBW Wall washer	141
4	120W Driver	82
5	T Connector	82
6	S Connector	173
7	DMX Controller	1
8	Splitter	4
9	Six Button Wall Panel	1
10	Beldan Cable	

Execution:

- In here we decided to make two bus, one is for front side of the building and another one for left side of the building. For front its labeled as U1 and for road side U2.
- Now from splitter to every floor of the building we need the beldam cable for data connection. Fig:7.2. a shows beldan single cable and power cable on below picture.

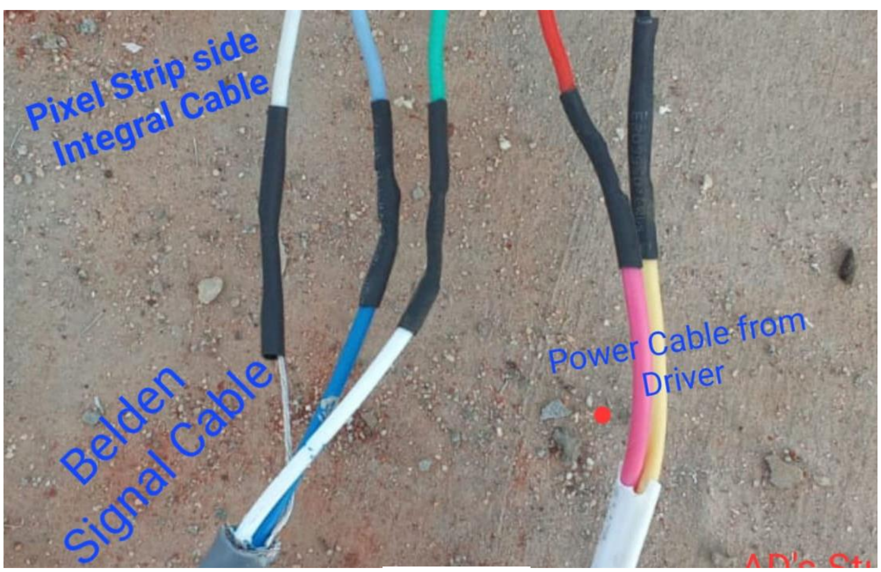


Fig:7.2.a

- Next step is to putting power to every luminaires by driver.fig:7.2.b shows driver on below image.

Fig:7.2.b

- Between two fitting connected with S connector so it can pass data and power connection separately.fig:7.2.c shows the connection between S connector and luminaires.

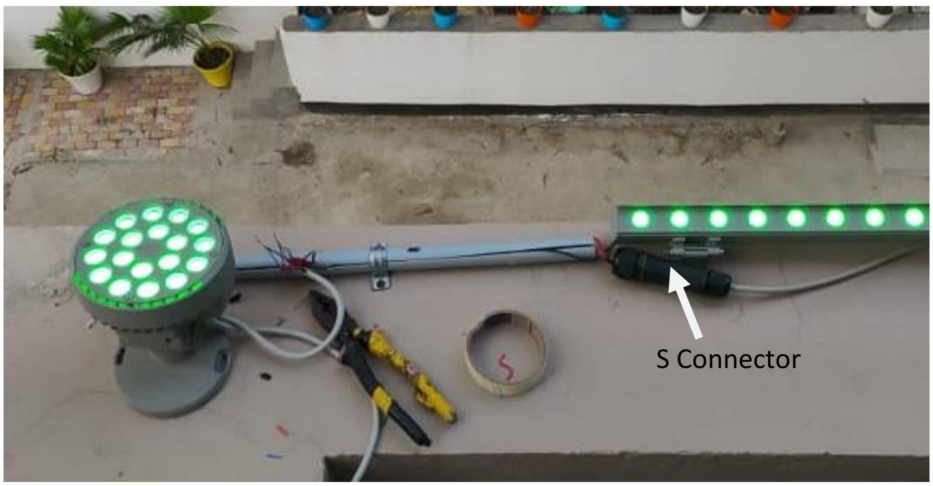


Fig:7.2.c

- From driver to fittings, T connector used for passing data and power connection separately. Below fig:7.2.d shows image of T connector.

Fig:7.2.d

- Now we have addressed every luminaire separately by addressor. Fig:7.2.e shows image of addressor.
- Every wall washer and flood light addressed for U1 and U2.
- Port has been shown below fig:7.2.e and checked on every RGBW scene.

Port For addressing

Fig:7.2.e

- Now splitter and DMX Controller connected.

Fig:7.2.d

7.3 Single line Diagram (SLD):

Using belden cable DMX controller connected with four splitter, shown in below fig:7.3.a.

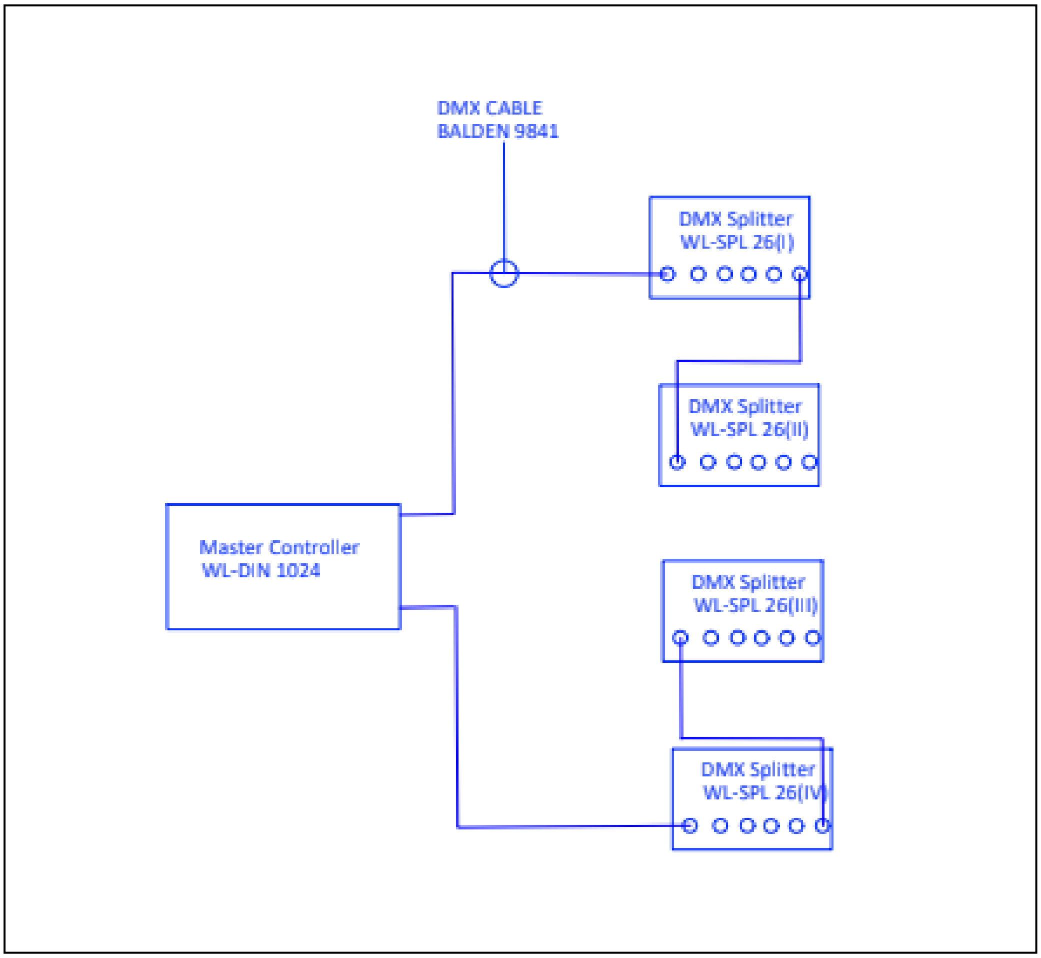


Fig:7.3.a

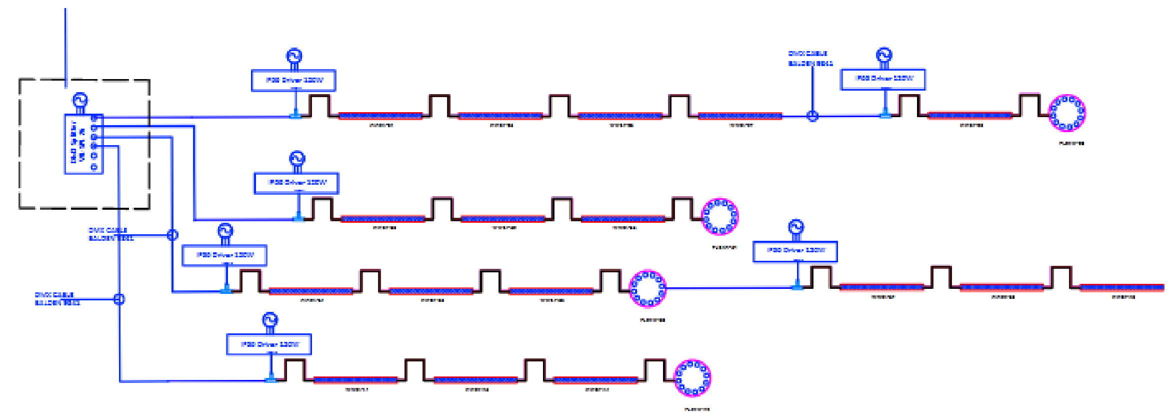


Fig:7.3.b

Here, from DMX controller two data line comes to two universes, which is connected by Beldan 9841 cable. For universe 1 splitter (I) and (II) connected in loop and for universe 2 splitter (III) and (IV) connected in loop.

Fig:7.3.b shows connection from a splitter to driver and driver to fittings .

As we can see splitter has 6 channels, one for input and other five for output to the fittings.

From splitter to driver T connector data line will be connected. From there 3 or 4 fittings will be connected and between every fitting S connector is connected.

Input channel is used for splitter-to-splitter connection.

From splitter 1 using XLR connectors connected to DMX controller. Where in beldan cable first wire connected to DMX1+, second one is connected to DMX1- and last one is connected to GND.

Fig:7.3.c and Fig:7.3.d shows male and female XLR connector.

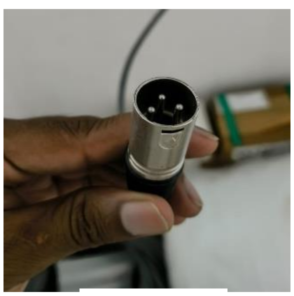


Fig:7.3.c

Fig:7.3.d

Fig:7.3.g splitter after Installation with connecting Beldan cable

Fig:7.3.b

7.4 Programming:

For programming PIXELERR software.

- At first, we put address and bus details on the software

Fig:7.4.a and Fig:7.4.b shows DMX controller on below images.

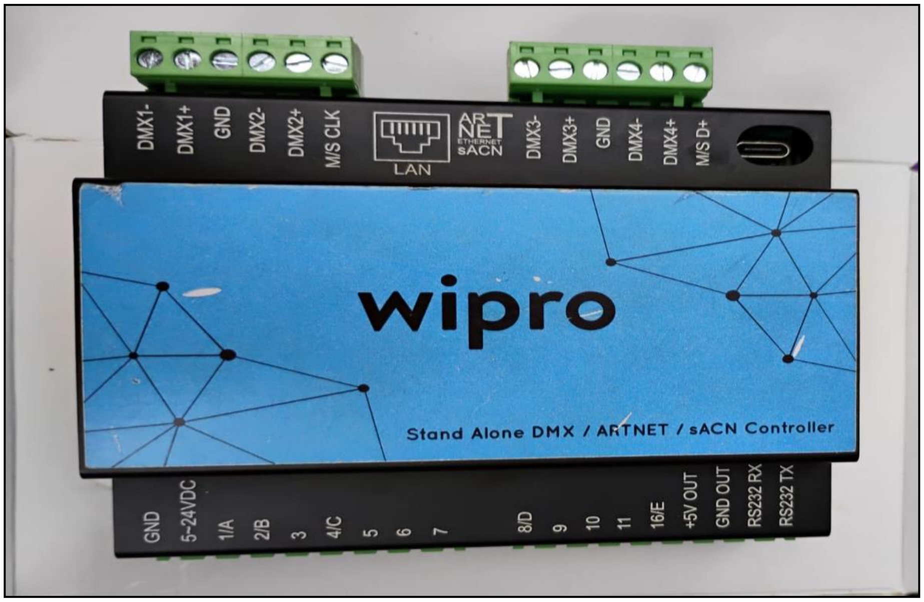


Fig:7.4.a

Fig:7.4.b

- Addressing LED Driver in PIXELERR software shown in fig:

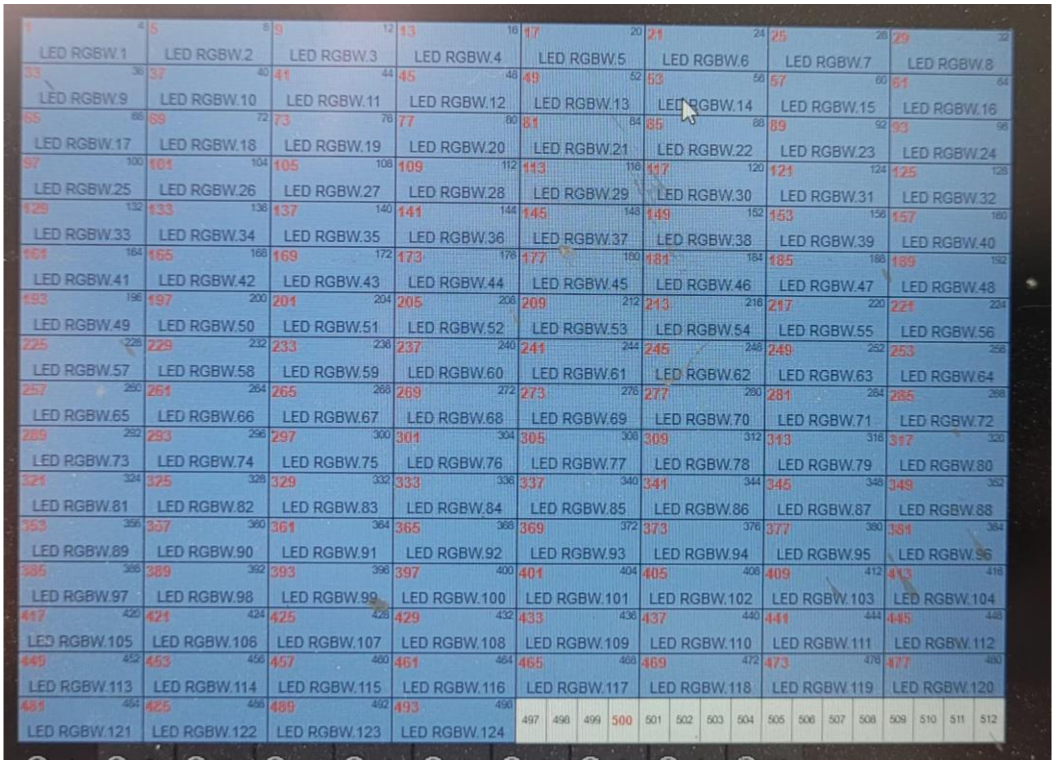


Fig:7.4.c

- Now we made some scene as per discussed with client shown in fig:7.4.d

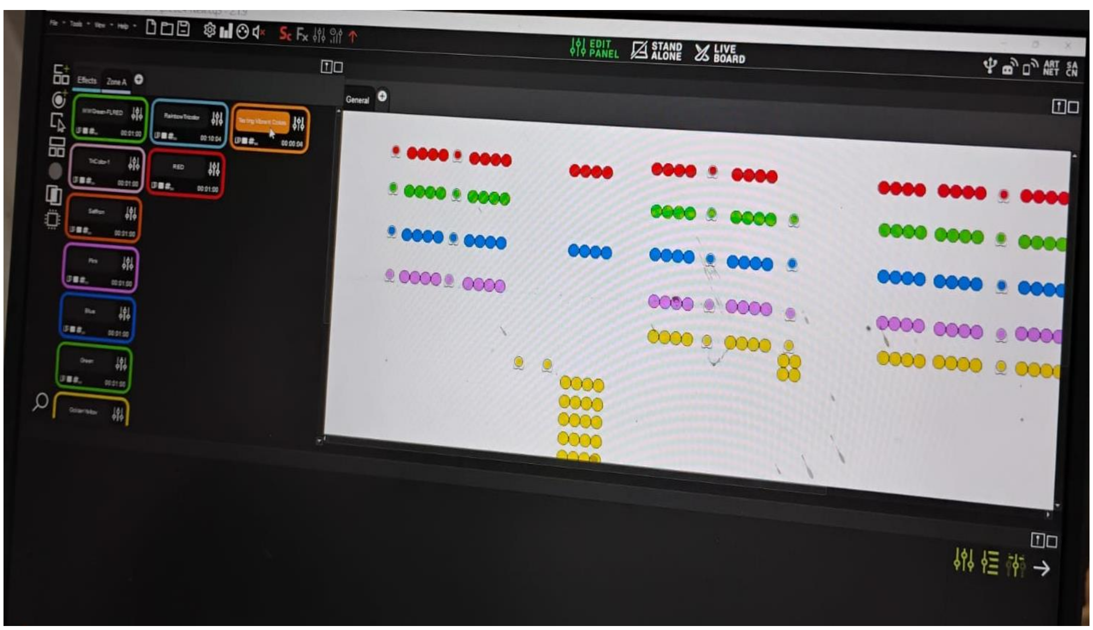


Fig:7.4.d

- Now we add timer like many seconds the fittings will be glowing in a scene
- Debug the programme into the DMX controller.

<u>Here is Scenes that has been added during programming:</u>

Fig:7.4.e shows different scenes and duration .

	Name	Duration	Properties	Triggers
1	WWGreen-FLRED	00m 01s ...	00:00:000 oo	
2	TriColor-1	00m 01s ...	00:00:000 oo	
3	Saffron	00m 01s ...	00:00:000 oo	
4	Pink	00m 01s ...	00:00:000 oo	
5	Blue	00m 01s ...	00:00:000 oo	
6	Green	00m 01s ...	00:00:000 oo	
7	GoldenYellow	00m 01s ...	00:00:000 oo	
8	White	00m 01s ...	00:00:000 oo	
9	DesignedTriColor	00m 01s ...	00:00:000 oo	
10	ContinuousScenes	00m 39s ...	00:00:000 oo	
11	RainbowTricolor	00m 10s ...	00:00:000 oo	
12	RED	00m 01s ...	00:00:000 oo	
13	Testing Vibrant ...	00m 01s ...	00:00:000 oo	
14	Magenta-1	00m 01s ...	00:00:000 oo	
15	Magenta-2	00m 01s ...	00:00:000 oo	

Fig:7.4.e

7.5. Scenes after Execution

After execution fig:7.5.1 shows multiple colour.

Fig:7.4.e

Fig:7.4.f and fig:7.4.g shows tri colour and blue scenes .

Fig:7.4.f

Fig:7.4.g

Fig:7.4.h and fig:7.4.i shows multicolor and magenta scenes .

Fig:7.4.h

Fig:7.4.i

8. Challenges & Future scope:

Façade lighting projects often encounter several significant challenges during execution. Firstly, achieving consistent reflection on a glass building is more complex compared to traditional buildings due to the varying reflective properties of glass surfaces. Glass tends to reflect light differently based on its angle, the quality of the glass, and the environmental conditions, leading to potential inconsistencies in the lighting effect.

Secondly, ensuring the luminaires are installed at the precise angle as per design specifications is critical. This involves meticulous calculations and adjustments to maintain uniformity and prevent issues such as glare, light spillage, and uneven illumination. Accurate mounting hardware and precise alignment tools are essential to achieve the desired lighting angles.

Thirdly, preserving the aesthetic view, particularly in areas governed by council regulations, requires careful planning of wiring routes. This involves concealing cables effectively while complying with safety standards and aesthetic guidelines. The use of conduit systems, strategic placement of junction boxes, and integration of wiring into architectural elements are common practices to maintain a clean and unobtrusive appearance.

Lastly, addressing errors in DMX programming is crucial, especially when using complex cabling systems like Beldan cables, which have three data lines and two power lines. Proper segregation and management of these cables are vital to avoid signal interference and ensure reliable operation. Utilizing proper DMX terminators, following best practices for cable layout, and employing diagnostic tools to detect and correct programming errors are essential steps in the troubleshooting process.

Both for interior spaces like conference and office rooms, as well as exterior façade lighting, holds significant potential for advancements in energy efficiency, sustainability, and aesthetic appeal.

For interior lighting, while the current use of DALI (Digital Addressable Lighting Interface) dimming functions provides a solid foundation for control and efficiency, integrating additional technologies such as daylight sensors and occupancy sensors can further enhance energy savings and sustainability. Daylight sensors adjust artificial lighting based on the availability of natural light, reducing energy consumption during daylight hours. Occupancy sensors, on the other hand, ensure that lights are only active when spaces are occupied, minimizing wasted energy. Together, these innovations can create smarter, more responsive lighting systems that adapt to real-time conditions, significantly lowering energy use and operational costs in conference and office environments.

In the realm of façade lighting, evolving from traditional wall washers and floodlights to dot lights can markedly improve the aesthetic impact. Dot lights offer higher resolution and more precise control over lighting effects, enabling more intricate and dynamic designs that can transform building exteriors into visually striking landmarks. This technology allows for greater flexibility in programming and can be used to create patterns, animations, and color-changing effects that enhance the building’s architectural features. Additionally, dot lights are typically more energy-efficient and have longer lifespans, contributing to both the visual appeal and the sustainability of the lighting installation.

Conclusion

For façade lighting, overcoming the complexities of glass reflections, precise luminaire alignment, aesthetic wiring integration, and DMX programming are critical to ensuring a successful installation. Future advancements, such as transitioning to dot lights, promise enhanced visual resolution and energy efficiency will allow more dynamic and sustainable architectural lighting solutions.

In conference and office room lighting, leveraging DALI dimming functions is a solid foundation, but incorporating daylight and occupancy sensors may further optimize energy use and sustainability. These technologies ensure that lighting systems are both responsive and efficient, reducing energy consumption and operational costs while maintaining comfort and functionality.

By integrating these advanced solutions and addressing key technical challenges, we can deliver lighting systems that meet all client requirements, achieving both aesthetic excellence and environmental responsibility.

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