STUDIES ON LIGHTING DESIGN FOR CONVENTION CENTER WITH ITS ALLIED AREAS

A thesis submitted towards partial fulfilment

of the requirements for the degree of

Master of Technology (Illumination Technology and Design)

Submitted by

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This is to certify that Miss Satabdhi Kargupta,, a student of M.Tech in Illumination Technology & Design ,Electrical Engineering Department, Jadavpur University, has worked as an Intern in the Lighting Advisory Bureau of Crompton Greaves Consumer Electricals Limited from 1st August, 2021 to 1st June, 2022.

The title of her thesis was "STUDIES ON LIGHTING DESIGN FOR CONVENTION CENTER WITH ITS ALLIED AREAS" which was carried out under the guidance of Mr. Sumit Kar, DGM – Design. During the tenure of her internship with us, she has been sincere, hardworking and diligent in carrying out the assignment entrusted to her.

We wish her all success in her future endeavour.

For CROMPTON GREAVES CONSUMER ELECTRICALS LTD

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Associate Vice President- Human Resources

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Abstract

In the last decade or so, India has seen year-on-year growth in tourism sector. Meetings and Conference market segment has been identified as one of the new growth market segments by many analysts. India will soon be competing with the best of the international markets in many industries including meeting and exhibition industry by attracting business arising from international summits, accords and conventions. Meetings, Incentives, Conference and Exhibitions (MICE) are today becoming an important segment of the tourism industry. With the opening up of India's economy, MICE tourism is likely to grow further in the future. Our country therefore needs more Convention and Exhibition Centers to meet the requirement of this lucrative segment of tourism. Taking this fact into consideration, therefore, the Ministry of Tourism has decided to grant an approval to convention centers to encourage investment and standardize facilities at the convention centers.

This thesis is based on the energy efficient lighting solution for convention center. Case studies have been carried out for different cases and the best possible lighting scheme has been proposed. The illumination level for the different area is selected as per the Indian Standards where lighting levels are mentioned for cases. Lighting simulation has been carried out using lighting simulation software like DIALux 4.13. The convention center is a place or a building designed for the purposes of convention, seminars, lectures, conferencing etc. The center brings delegates from different parts of the country and the world at large to share common interest and ideas towards development, therefore, there is need to design a convention center that will be energy efficient. The lighting design and simulation works in the subsequent chapters are performed in Crompton Greaves Consumer Electricals Limited, Mumbai Regional Headquarter during the internship period.

TABLE OF CONTENTS

CHAPTER-1: AIMS AND OBJECTIVES

1.1: AIMS:

Light in common term describe something that helps a human being to perceive vision in the darkness. However, the subject physics describe light in a different sense. Light is a spectrum of electromagnetic radiation which may or may not be visible having varying wavelength ranging from Gamma Rays to Long range radio waves. The wavelength for visible light ranges from 400nm-700 nm. This visible range of light is applicable to human eye. However, for animals this range goes well into ultraviolet range also. Light received from Sun serves the purpose of all major activities during daytime. But at night time Moon light and light from stars do not help us in much effective way. Although for nocturnal species and animals this moon light helps to migrate in search of food and shelters. Natural Day-Night cycle helps animals and plants to adjust their activity accordingly. However, for human being after dark time artificial light comes into picture. For humans this light is helpful to see in darkness and to perform other activities. But recent studies have uncovered how artificial light is disrupting the plants and animals. Electric lighting is transforming our world. A large portion of the world-wide population now lives in places where night skies are polluted with artificial light. Due to which majority cannot see the stars at night time. But light at night has deeper effects. In humans, nocturnal light pollution has been linked to sleep disorders, depression, obesity, anxiety etc.

Effective and proper lighting design not only saves energy but also reduces the light pollution. In present scenario one of the prime factors which decides how good the design has been made is by analyzing that the achieved illuminance value has been obtained by using least possible number of fixtures in efficient way,

Lighting design starts by developing the objectives and then quantifying these by specifying the criteria. When looking to objectives, the lighting designer will consider:

- day lighting and how it is used
- types of artificial lighting to be considered
- required light levels and uniformity
- types and methods of lighting control
- maintenance of the lighting system
- the efficiency goals of the lighting system

Over the last hundred years, a lot of achievements took place with the development of artificial light. Incentives of developing a proper lighting scheme are increased safety in cities & dwelling areas, enough light in dark rooms during the daytime, more working hours even during the night with bright light and the application of light in science and engineering. In the last couple of years, the energy efficiency increased with the advancement of fluorescent lighting, and for the last 15 years, another leap towards lower energy consumption came through the development of LEDs. In the last 20 years, the effect of light on health and well-being was better understood and scientifically studied. But the idea was always to have light for good vision and low energy consumption.

Lighting industry plays a significant role in modern infrastructural developments. It lends a fresh lease of life to the building design. Nowadays major events, meeting, trade related interactions are taking place in convention centers, which boasts of world class facilities.

International summits, conferences are also a major part of such centers. The development of convention centers, sports facilities and performing arts venues are increasingly being acknowledged for their role in integrating local economies and improving the quality of life of a nation's citizens. Conference and business meets are also enhancing the global tourism industry. The modern convention centers not only consist of convention center but also is equipped with exhibition facilities, shopping plazas, cluster of hotels, backward-forward linkages with international airports, mass transit systems and adequate parking.

In this thesis a brief study has been carried out to gain knowledge about lighting design in a convention center. Case studies have also been made to compare results with standard lighting design.

1.2: OBJECTIVE:

The objective of the thesis work is described below: -

- To design a convention center that will be energy efficient.
- To study the illumination design criteria of different areas of the convention center and to design those areas following relevant codes and guidelines of illumination as well as energy parameters with the help of illumination software like DIALux 4.13.
- To simulate the designs by using energy-efficient LED luminaires and compare the results based on illumination and power consumption parameter and calculated LPD value with standardised values.

CHAPTER-2: ABOUT THE PLACES OF DESIGN

2.1: **INTRODUCTION:**

A convention center is basically a large building that is designed to hold a convention where individuals and groups gather to promote and share various agendas, activities and so on. A convention center is designed in most cases for the purpose of conducting meetings, conferences, exhibitions and seminars. It may also be adapted for specific events. such as appearances by well-known speakers or musicians. In some cases, meetings or other events take place in centers or buildings not specifically designed for conventions but large enough to accommodate attendees.

Convention centers receive guests from local, national and international places. The various market segments that visit these facilities are dictated by the types of events that are hosted.

Fig 2.1.1: TYPICAL CONVENTION CENTER

Fig 2.1.2: PROPOSED CONVENTION CENTER

2.2: <u>CLASSIFICATION OF USER FOR CONVENTION CENTER:</u>

The users of the center are broadly classified into three major types:

The delegates:
These are the group of people who form the major part of the convention center. People from both national and international backgrounds are a part of this user groups.

The exhibitors:
They are the reason for the delegates to attend various conventions and exhibitions. People from all over the country gather to promote their respective event. The exhibitors may also be local craftsmen who are allowed to setup temporary shops.

The staff:
These people form the backbone of the convention center. They take care of all the needs of the delegates as well as the exhibitors who are new to the place and a guest at the convention center. The building must cater to their needs along with catering to the direct users of the building.

2.3: <u>TYPE OF CONVENTIONS:</u>

The most common conventions are based upon industry. profession. and fandom, along with them.

Trade conventions: It typically lays focus on a particular industry or industry segment, and feature key note speakers, vendor displays and other information and activities of interest to the event organizers and attendants.

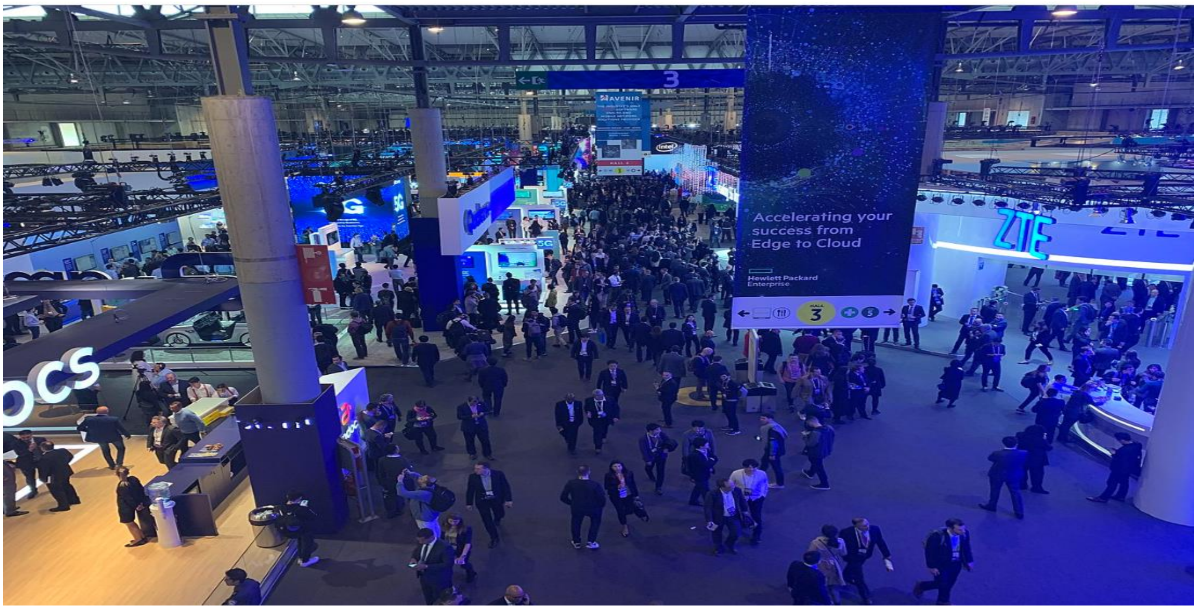


Fig 2.3.1: Trade fair inside the convention center

Professional Conventions: They focus on issues of concern to the profession and advancements in the profession. Such conventions are generally organized by societies dedicated to promotion of the topic of interest.

Fig 2.3.2: Professional seminar occurred inside the convention center

Seminars: They are meetings organized to inform a group of people about a specific topic, or to teach a specific skill. Expert speakers and teachers are usually involved to speak on various topics.

Fig 2.3.3: Seminar room inside the convention center

Social events: A large gathering organized to celebrate major life event and religious ceremonies. Common social events include: anniversary, weddings and birthdays.

Fig 2.3.4: Convention Hall inside the convention center

Trade shows/ Exhibitions: They are an opportunity for companies to exhibit some of their latest products as well as yet to be released prototypes to journalists as well as others in the industry.

Fig 2.3.5: Convention Hall inside the convention center

2.4: SPACE AND USER ANALYSIS:

Table 2.4.1: space and user analysis

COMPONENTS	SPACE ANALYSIS
PUBLIC USE	
Entrance Hall	**Users:** Delegates, performers and staff. **Description:** 1. The major connectivity between the various components of the convention center. 2. It acts as an ideal space for delegates to network. 3. Spaces like information kiosk and waiting lounges form a part of the entrance hall.
Registration Center	**Users:** People taking part in various conventions **Description:** It acts as a space where people attending various events register themselves.
Exhibition Halls	**Users:** All occupants **Description:** 1. Trade relative promoters take part in the trade shows to promote their products. 2. Large span structures and column free spaces are required for these promotions. 3. Crowd management of such components becomes necessary.
Toilets	**Users**: All occupants. **Description**: 1. The size and quantity of the toilets to be provided shall be decided in accordance to NBC standards. 2. They shall be provided for peak capacity.

SEMI-PUBLIC USE	
Auditorium Hall	**Users**: Performers, delegates and local people. **Description**: 1. The purpose of the auditorium is to accommodate large scale gatherings for various events like dance, drama and delegations. 2. The design of the auditorium shall be evolved in accordance to various standard guidelines subjected to auditorium design.
Conference Rooms	**Users**: Delegates and staff. **Description**: 1. They hold meetings and small company training sessions for 20-30 people.
Seminar Rooms	**Users**: Delegates and staff. **Description**: 1. They are ideal for small-scale events like workshops, training sessions, press conferences. etc. 2. They are large enough to seat attendee's 1n theatre configurations ranging from 50-200 people.
Public amenities	**Users**: Delegates **Description**: 1. They include smoking lounges, ATM's, phone booths, etc. 2. Only people attending any event in the convention center shall have an access to these amenities.
PRIVATE USE	
Administrative offices	**Users**: Staff of the convention center **Description**: 1. It contains offices for the convention center which handles the general functioning of the bus terminal.

Control room	**Users**: Staff **Description**: control room will monitor the overall functioning of convention center.
SERVICE AREA	
Service Block- AC Plantroom, Electrical substation, Maintenance Depts.	**Users**: Staff
The Kitchen	**Users**: Staff **Description**: 1. It shall serve all the events hosted by the convention center.
Parking	**Users**: Any one visiting **Description**: 1. Car and bus parking as per standard norms.
Loading Docks/Bays	**Users**: Staff **Description**: 1. They form a crucial part for loading/unloading purpose in the exhibition pavilions.

2.5: PUBLIC MOVEMENT PATTERN FOR CONVENTION CENTERS:

Communication and functionality can be improved by implementing efficient circulation patterns in a convention center. People visiting or working in a convention center can be divided into 5 broad user categories:

1. **Delegate flow**
2. **Public flow**
3. **VIP flow**
4. **Staff flow**
5. **Journalist flow**

1. **Delegates flow:**

Delegates form the most important group of users for a convention center. The parking shall lead them to the main entrance foyer which further directs them to their destination. An unobstructed delegate movement is very important.

2. **Public flow:**

Dignified personalities are invited depending on the nature of conference. It can also have relatives and public guests invited by the organization. The public guests also have access to the exhibition areas and hence these areas shall have a separate access to manage the public during peak hours efficiently.

3. **VIP flow:**

They shall either directly lead to the dais of the main hall or shall enter through the VIP entrance which is connected to a VIP lounge.

4. **Staff flow:**

The staff can be divided into two categories namely the technical staff who are responsible for the efficient working of the convention center while the others are the administrative staff who are exposed to the people coming to the center. The paths of the technical and administrative staff bifurcate at the staff entrance.

5. **Journalist flow:**

It includes press people, cameraman and diplomats. They shall have a direct access to the documentation center and the TV studio of the convention center.

2.6: THE MICE INDUSTRY:

MICE, an acronym for the Meetings Incentives, Conventions and Exhibitions tourism segment is a type of tourism in which large groups, usually planned well in advance are brought together for a particular purpose. The Incentives part of MICE is the odd one out though it is related to business as it is usually provided to employees or dealers or distributors as a reward it tends to be leisure based.

Meeting : Coming together for a specific reason
Incentives : An initiative that motivates
Conferences : A meeting for consultation or discussion
Exhibitions : A public display

2.7: IMPORTANT AREA INSIDE THE COVENTION CENTER:

2.7.1: THE AUDITORIUM:

An enclosure covered or open wherever people will assemble for watching a performance given on the stage. Auditorium could be space built to enable audience to listen to and watch performances at venues like theatres. Auditoria can be found in entertainment venues, community halls, and theatres, and may be used for rehearsal, presentation, performing arts productions.

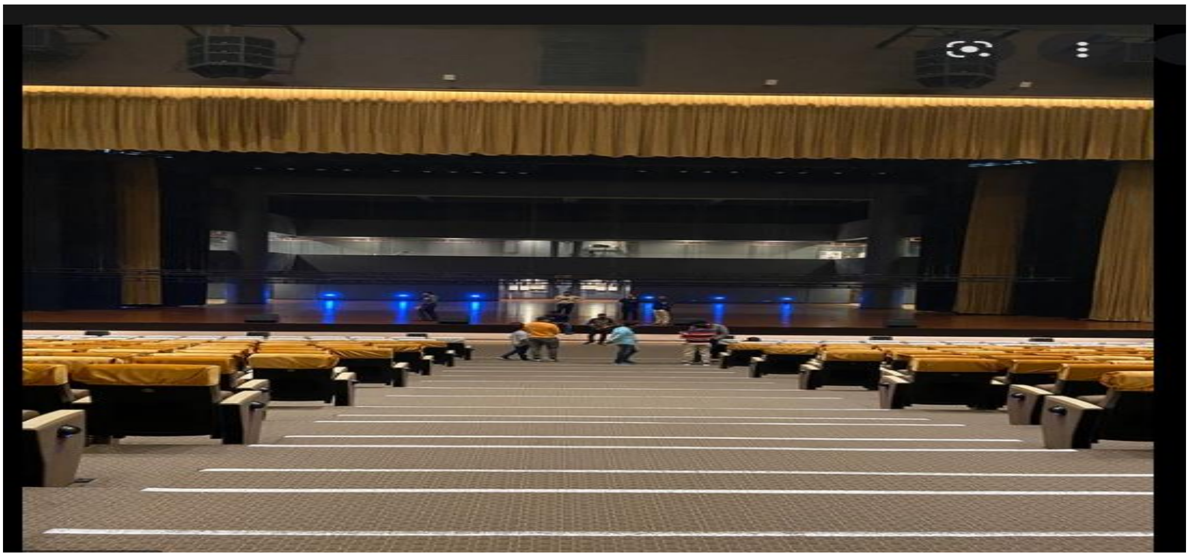


Fig 2.7.1: Auditorium

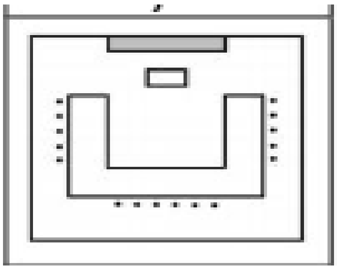
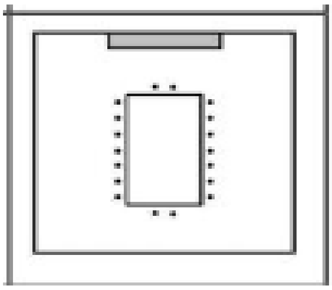
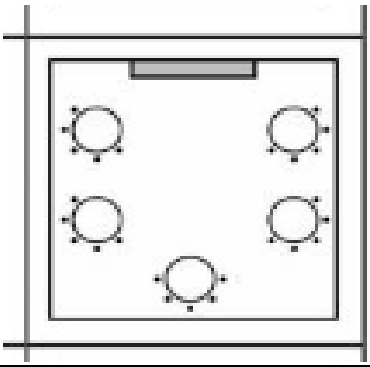
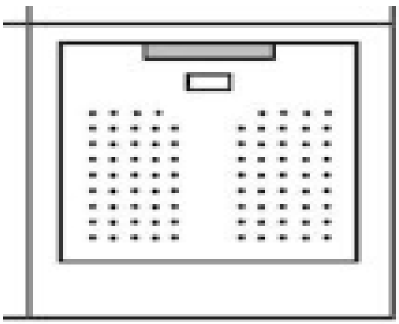
2.7.2: CONFERENCE ROOM:

A conference hall or conference room is a room provided for singular events such as business conferences and meetings. Sometimes other rooms are modified for large conferences such as arenas or concert halls. Conference rooms can be windowless for security purposes.

Fig 2.7.2: Conference Hall inside the Convention Center

2.7.2.1 TYPE OF SEATING:

Table 2.7.2.1 Different Type of Seating at conference hall

U shaped 1. Seating around three sides of the room 2. It's good for presentation from front 3. Presentation space in the middle room 4. Can be used for 50 persons	
Board room style 1. Centrally located table 2. Classic layout idea for debate and discussion 3. Seating capacity 5 to 30 person	
Cabaret style 1. All delegate facing front center on round tables 2. Large space in the middle of the room 3. Idea for small group work	
Theatre style 1. Used for product launch presentation displays 2. Used to present number of delegates 3. Can be used for 100-250 persons	

2.7.3: <u>EXHIBITION GALLERIES:</u>

An Exhibition is an organized presentation and display of a selection of items. In practice, exhibitions usually occur within museums, galleries and exhibition halls and World's Fairs. Exhibitions can include many things such as art in both major museums and smaller galleries, interpretive exhibitions, natural history museums and history museums, and also varieties such as more commercially focused exhibitions and trade fairs.

Fig 2.7. 3.1: Gallery inside the Convention Center

Fig 2.7.3.2: Exhibition Center Trade Fair inside the Convention Center

CHAPTER - 3: ILLUMINATION DESIGN OBJECTIVES AND CRITERIA

3.1: INTRODUCTION:

In recent years the area of illumination industry has been waging two-pronged battel with energy efficiency and lighting quality. Lighting designers initially accosted with the predicament of selecting between attractive, well- lighted spaces and spaces that used a minimum of amount of energy. Lighting design can have an assortment of targets. Ideally, these targets are chosen by the collaboration between the clients and the designers. This chapter discusses in brief about the design objectives and criteria that an illumination designer needs to follow.

3.2: ILLUMINATION DESIGN OBJECTIVES:

i. Safety and Health

Interior lighting should enable the occupants to see sufficiently well to work and move about in safety both under normal conditions and in the event of an emergency involving power failure. Lighting must not create conditions, which are injurious to people health.

ii. Performance

The type of work that takes place and the characteristics of the workforce together define the nature and variety of visual tasks in an interior workplace. The quality and quantity of lighting required to achieve satisfactory visual conditions depend upon these tasks.

iii. Appearance and Comfort

The way in which the space is illuminated can affect its character and appearance of objects within it. Where the creation of the state of mind or environment is overwhelming this must be the prime lighting objective.

iv. Architectural Integration

Understanding the space plays a significant role deciding on what lighting is to be employed. The texture and colour of the materials framing the space and the appearance of the luminaires, lit and dim should be considered if the desired atmosphere is to be attained.

v. Energy Efficiency & Sustainability

It is constantly urged to utilize energy as efficiently as conceivable without compromising with the visual function that the lighting has to serve. Efficient lamps, luminaires, and control circuits help to accomplish energy efficiency. It is also necessary for the lighting industry to use sustainable equipment

vi. Maintenance

It is realized that both daylight and artificial light depreciate with time. A maintenance and support program should have been structured and actualized to capture that impact. As the maintenance programmed assumes a noteworthy job in lighting design, the designer will need to state the maintenance programmed on which the design has been base.

vii. Finance

Venture cost or project cost is a significant factor. The cost of every project has two sections: capital costs and running costs. Capital costs are the main thing that should have been concurred by the client. The running or operational costs include the cost of the electricity consumed, which comprises items such as standing charges, maximum demand charges, and electricity unit costs. They will also include the cost of maintenance, which includes cleaning and re- lamping throughout the life of the installation.

3.3: ILLUMINATION DESIGN CRITERIA:

Light – quality and features:

- **MODELLING OF OBJECTS AT STAGE:**

One essential aspect of lighting design is to reveal the three-dimensional impression of people and objects in space, and this has to be achieved by the balanced use of both light and shadows. As mentioned earlier, direct lighting creates harsh shadows, which in turn can conceal details of objects. On the other hand, indirect lighting creates negligible shadows, due to which shapes and structures are poorly recognizable. Hence both directional and diffused lighting is required for 3-D modeling of objects in a space. The picture below shows how 3-D modeling of an object is created by uniform lighting using several light sources.

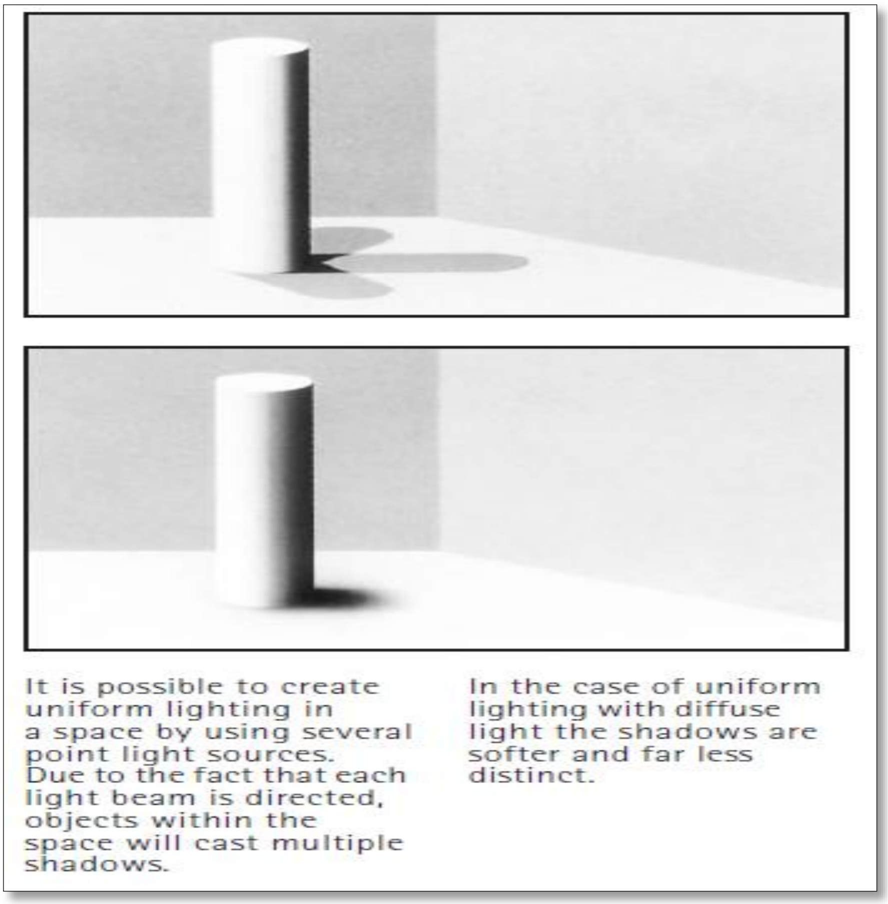
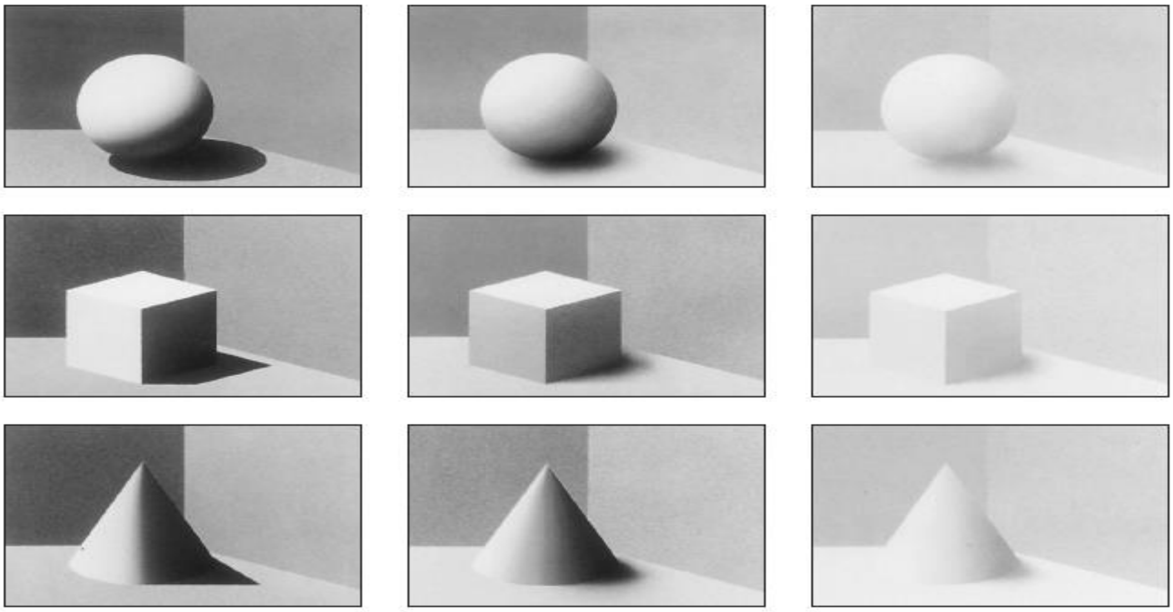


Fig3.3.1:3D Modelling of An Object Using Uniform Lighting of Several Light Source

➢ DIRECT, INDIRECT AND DIFFUSED LIGHT:

Direct light is obtained when the light source shines directly on the surface to be illuminated, without any filter. It can be used where focused lighting is required, but direct light also creates the risk of glare and harsh shadows. Indirect lighting is obtained when light falls upon a surface after being reflected off other surfaces such as wall, ceiling, etc. This kind of lighting is mainly used for ambience lighting. A big advantage of indirect lighting is that it produces no glare and does not create shadows. Diffused lighting is obtained by usage of filter over the light source. It generates a balanced distribution of light in a space, and is often used in a combination with direct and indirect light. The pictures below show how 3-D objects are perceived under direct, indirect, and diffused light, creating different shadows and shaping the objects differently.



Perception of three-dimensional forms and surface structures under different lighting conditions.
Directed light produces pronounced shadows and strong shaping effects. Forms and surface structures are accentuated, while details can be concealed by the shadows.

Lighting that consists of both diffuse and directed lighting produces soft shadows. Forms and surface structures can be recognised clearly. There are no disturbing shadows.

Diffuse lighting produces negligible shadowing. Shapes and surface structures are poorly recognisable.

Fig 3.3.2: Perception of 3D objects under different kinds of lighting

➢ CORRELATED COLOUR TEMPERATURE:

Correlated Colour Temperature, specified in Kelvin, indicates the colour of light emitted by a light source. It is the temperature of an ideal black body radiator that radiates light of comparable hue to that of the light source.

2700K – 3500K light is called warm white colored light
4000K light is called natural white colored light
5000K light is termed as daylight
6000K – 6500K light is called cool white colored light

Fig 3.3.3: Different levels of CCT

- **COLOUR RENDERING INDEX**:

The Colour Rendering Index of a light source indicates the colour quality of the object it illuminates. The more the CRI, the more accurately it represents the original colour of the object. It is measured on a scale of 1-100, where 1 means monochromatic light is rendered and 100 means all colours are rendered. Sunlight produces a CRI of 100 Light sources with CRI of 85-90 are considered very well at colour rendering.

Fig 3.3.4: Effect on objects under luminaires with different levels of CRI

CHAPTER-4: ILLUMINATION DESIGN METHODOLOGY

4.1: <u>INTRODUCTION:</u>

This chapter deals with the various considerations taken in account for successful completion of the project. The assumptions made the luminaire specifications and the tools used have also been mentioned in this chapter.

4.2: <u>INPUT DATA:</u>

- **Drawing of the area describing plan and elevation:** In this section dimension of the area is considered. Information about the type of ceiling and any constraints in locating the luminaires is noted beforehand. If AutoCAD layout drawing is not available direct site survey can be conducted to get these details.

- **Reflection Properties of Surroundings:** This data helps in deciding the reflection factors of the ceiling, walls and floor. Normally the client does not specify this data. In such cases, the environmental condition prevailing in the area and experience of the designer helps in deciding the reflection properties. A thorough site survey may help in knowing the actual scenario.

- **Required Illumination Level:** This will help in deciding the illumination level for the particular type of application from Indian Standards.

- **Layout and Heights of Installation:** This will help in location of luminaires and also determining the working plane height. From AutoCAD layout the idea of elevation is noted. Sometimes end user have specific constraints in height of luminaire to be placed.

4.3: <u>METHOD OF LIGHTING:</u>

There are various ways lighting can be done i.e., lighting may be recessed, surface mounted, wall mounted direct or indirect, or up-lighting. This depends upon the requirement of user and the area of application.

4.3.1: SELECTION CRITERIA OF THE LIGHTING EQUIPMENT

Once the approach of lighting is finalized, the most suitable lamp and luminaire is chosen. The following attributes should be studied while choosing the light source

- Light output(lumens)
- Total input Power Consumption
- Efficacy (lumens per Watt)
- Surface brightness /glare
- Colour characteristics
- Electrical characteristics

- Requirement for control gear
- Compatibility with existing electrical system
- Suitability for the operating environment

Technical criteria's of selecting Luminaire are mentioned below

- Characteristics of the light source and control gear
- Luminaire efficiency (percentage lamp light output transmitted out of the fixture)
- Electrical and Photometry parameters
- Aesthetic and dimension
- Accessibility for maintenance
- IP rating and IK rating
- Diffuser/Optical material
- Thermal management

4.4: LIGHTING CALCULATION METHODS:

Lighting calculations methods fall into three broad categories:

I. Manual Calculation Method
II. Three-Dimensional Modelling
III. Visualization

I. Manual Calculation Method:

There are a wide scopes of manual computation strategies for the calculation of different lighting aspects. These include complex methods for calculating the illuminance from wide variety of shapes of luminous objects. The majority of these now have been superseded by computer programs.

Lumen Method: The Lumen method is the fundamental for interior lighting and has remained in use as a quick and relatively accurate method of calculation interior illuminance. The Lumen Method calculates the average illuminance at a particular level in the space, including allowance for the light reflected from the interior surfaces of the room.
The formula given by:

$$E = \frac{N * Ø * UF * MF}{A}$$

E = average illuminance over the working plane
N = number of luminaires
Ø = luminous flux of each luminaire
UF = utilization factor
MF = maintenance factor
A = area of the horizontal working plane

Utilization Factor or Co-efficient of Utilization (UF or COU):
This measures the efficiency of the lighting scheme to deliver the light to the working plane relative to the room/environment it is operating within. This consolidates the proportion of flux arriving the working plane from both the direct and reflected off other surfaces encasing the room/environment. Utilization factor takes into account:

- Luminaire efficiency
- Luminaire distribution characteristics with respect to: Room proportions, Surface reflectance and Mounting height.

Maintenance Factor (MF):
Maintenance factor is defined ratio of the mean illuminance on the working plane provided by the lighting installation in an average condition of dirtiness and the mean illuminance when it is clean.

MF = RSMF x LMF x LSF x LLMF

where,

RSMF (Room Surface Maintenance Factor):
Takes account of the effect of dirt and dust accumulation and other degradation of the reflectivity of the room surfaces. The main determining factor is the environment which can be classified on a sliding scale from Very Clean to Dirty.

LMF (Luminaire Maintenance Factor):
Takes account of the effect of dust and dirt accumulation on the luminaire. Luminaires are classified according to their degree of sealing and their distribution, obviously dust accumulation on an open up light is far more onerous than on a sealed downlight.

LSF (Lamp Survival Factor):
Takes account of the effect of the failure of light sources during the maintenance period.

LLMF (Lamp Lumen Maintenance Factor):
Takes account of the effect of the lumen depreciation of the light sources during the maintenance period.

II. Three-Dimensional Modelling

Although it was possible to calculate the luminance of all the surfaces in the room, the calculations were extremely laborious and could only be justified in the most special cases. However, the occurrence of computer modelling enabled a more flexible approach to lighting design and significantly increased the information available to the designer.

III. Visualization

These are complex calculation processes that perspective rendering of the space in levels of detail that vary from a block representation of the space, to the photographic quality renderings depending on the sophistication program and the level of detail of the interior to be entered. The programs fall into two basic types:

Flux transfer or Radiosity calculations: A flux transfer or radiosity program regards all surfaces as diffuse therefore there rendering will in general show up level with delicate shadow subtleties. It will in general overestimate the uniformity

Ray Tracing Calculations: Ray tracing follows the individual beams of light from the source to the eye as it reflects from surface to surface around the room. As a result, ray tracing can permit the specular segment of the surfaces.

4.5: DESIGN TOOLS:

Lighting Design Software

There are different types of lighting simulation software among them the popular ones are named below:

Among the above Software's DIALux 4.13 has been used for case study in this thesis work because of the following reasons

- A simple tool for light planning.
- Variety of Luminaire data can be imported from company's database.
- Open-Source Software
- Energy evaluation facility and lighting control system facility.
- Lux level calculation in presence of integrated daylight and electrical light sources.
- Colored light scenes with LED or other color changing luminaires

AutoCAD

AutoCAD is an architectural tool which provides complete information on the dimensions of the room like length, width and height of the room. And after the completion of the design, the same can be used to provide the lighting layout as well. The AutoCAD file can be imported to DIALux software to get the room layout and luminaire position as per user requirement. This helps in execution of the project as different disciples get to know the actual site condition.

4.6 : DESIGN METHODOLOGY:

- **Client Meet & Discussion**:

  For any designer, the first step is to have a discussion with the client or end user to get knowledge of the utility function of the space hence get an idea about how to proceed with the design.

- **Acquiring the AutoCAD layout:**

  To obtain the AutoCAD layout plans and elevation plans of the project and study them thoroughly in order to construct areas of correct dimensions in the design software so that appropriate luminaires can be chosen and optimally arranged.

- **Study of guidelines**:

  Study the relevant codes, guide lines in detail. For indoor lighting design IS:3646-1992 (Part I & Part II), National lighting code SP 72:2010, Road lighting design IS:1944, Industrial lighting design IS:6665-1972 etc. For LPD guidelines ECBC 2017 is referred.

- **Design Simulation with the Site layout**:

  For this project, DIALux 4.13 software is used for illumination design. When importing an AutoCAD file into DIALux, one should be careful about the dimension unit in the AutoCAD drawing. Many a times the AutoCAD drawing is not scaled properly, and hence has different dimensions that what is mentioned in it. So, an AutoCAD drawing must be checked to see if it is scaled properly, and if it is not, then it must be scaled to the correct dimensions.

- **Selection of Luminaires:**

  Every area is different; hence each area requires different types of luminaires too, mainly according to its function. The quantity of course depends on the dimensions and work plane height.

- **Analysis of result:**

  If the simulation does not comply with the standards, or if the client asks for a specific requirement, a review is done on that and redesigning is done until the standards are met, and the client is satisfied.

- **Analysis of LPD values**:

  The LPD (Lighting Power Density) value analysis of the spaces in the building is carried out using different luminaires and the one which gives the lowest LPD is suggested to the client as it has lowest Power Consumption.

CHAPTER -5: REFERRED CODES AND STANDARDS

5.1: CODES AND STANDARDS UNDER DESIGN METHODOLOGY:

The codes and guidelines which are consulted for illumination designing of different areas of convention centre

Codes and Guidelines consulted for illumination design of convention center:

SL. No.	Standard	Title
Codes and Standards followed for convention centre Illumination Design		
1	IS: 3646 (Part-I) 1992	Code of Practice for Interior Illumination
2	SP 72:2010	National Lighting Code
3	NBC 2016	National Building Code

5.2: CODES AND STANDARDS FOLLOWED FOR CONVENTION CENTRE ILLUMINATION DESIGN:

THE LEVELS OF ILLUMINATION AS PER IS:3646 (PART-I) 1992 AND NBC 2016 FOR CONVENTION CENTER ILLUMINATION DESIGN ARE AS FOLLOWS:

Table 5.2.1: Illumination levels for convention centre Illumination Design as per IS:3646 (Part 1) and NBC 2016

SL. No.	TYPE OF INTERIOR OR ACTIVITY	RANGE OF SERVICE ILLUMINANCE (lux)
1	**PLACES OF PUBLIC ASSEMBLY**	
1.1	Public Rooms, Village Halls, Worship Halls	200-300-500
1.2	**CONCERT HALLS, CINEMAS AND THEATRES**	
1.2.1	Foyer	150-200-300
1.2.2	Booking office	200-300-500
1.2.3	Auditorium	50-100-150
1.2.4	Dressing rooms	200-300-500
1.2.5	Projection room	100-150-200

1.2.6	Bathroom	50-100-150
1.3	**DISPLAY AND EXHIBITION AREAS**	
1.3.1	Exhibits insensitive to light	200-300-500
1.3.2	Exhibit sensitive to light, for example, pictures, prints, rare books in archives	50 to 150
1.4	**MUSEUMS AND ART GALLERIES**	
1.4.1	Exhibits insensitive to light	200-300-500
1.4.2	Light sensitive exhibits, for example, oil and temper paints, undyed leather, bone, ivory, wood, etc	150
1.4.3	Extremely light sensitive exhibits, for example, textiles, water colours, prints and drawings, skins, botanical specimens, etc	50
1.4.4	Conservation studies and workshops	300-500-750
1.5	**EDUCATION**	
1.5.1	Assembly Halls General	200-300-500
1.5.2	Lecture Theatres General	200-300-500
1.5.3	Demonstration benches	300-500-750
1.5.4	Seminar Rooms	300-500-750
1.5.5	Music Rooms	200-300-500
1.5.6	Workshops	200-300-500
1.6	**GENERAL BUILDING AREAS**	
1.6.1	Entrance halls, lobbies, waiting rooms	150-300-300
1.6.2	Enquiry desks	300-500-750
1.6.3	Circulation Areas Lifts	50-100-150

1.6.4	Corridors, passageways, stairs	50-100-150
1.**7**	**STAFF RESTAURANTS**	
1.7.1	Canteens, cafeterias, dining rooms, mess rooms	150-200-300
1.7.2	Servery, vegetable preparation, washing-up area	200-300-500
1.7.3	Food preparation and cooking	300-500-750
1.8	**COMMERCE**	
1.8.1	General offices	300-500-750
1.8.2	Conference rooms, executive offices	300-500-750
1.8.3	Computer and data preparation rooms	300-500-750

THE LEVELS OF ILLUMINATION AS PER NATIONAL LIGHTING CODE 2010 FOR CONVENTION CENTER ILLUMINATION DESIGN ARE AS FOLLOWS:

Table 5.2.2: Illumination Values and Glare Index for different area in indoor Design as per NLC 2010

AREA	ILLUMINATION	GLARE INDEX
Lecture room	300	16
Reading room	150 to 300	19
Corridors	70	_
	Auditorium	
Hall	70	_
Foyer	70	_
Stage area	300	16
Cafeteria	100	_
Staff room	150	_

IS: 3646 (PART 2)-1992: SCHEDULED FOR VALUES OF ILLUMINATION AND GLARE INDEX

According to IS-3646 (Part 2), the Glare index i.e., Unified Glare Rating (UGR) values are shown in below.

Table 5.2.3: UGR values corresponding to Discomfort Glare Criterion

UGR	Discomfort Glare Criterion
10	Imperceptible
13	Just Perceptible
16	Perceptible
19	Just Acceptable
22	Unacceptable
25	Just Uncomfortable
28	Uncomfortable

5.3: <u>ENERGY CONSERVATION CODES AND GUIDELINES</u>

The Energy Conservation Building Code (ECBC), was launched by Ministry of Power, Government of India in May 2007, as an initial step towards promoting energy efficiency in the building sector. The ECBC was developed by an Expert Committee, set up by India's Bureau of Energy Efficiency, with support and guidance from United States Agency for International Development (USAID) and significant inputs from various other stakeholders such as practicing architects, consultants, educational institutions and other government organizations. Unlike ECBC 2016, ECBC 2017 has divided building rating into three divisions i.e., ECBC Building, ECBC+ Building and Super ECBC Building depending upon least energy usage by satisfying all the criteria. The guidelines have been furnished in the following tables.

5.3.1: <u>BUILDING AREA METHOD</u>

This method provides the procedure of calculating Watt/Sq. meter for the entire building based on this method. The sum of all interior lighting powers for various areas of the building should not exceed the total watts to be compliance as per table furnished herein after. In this section, the values of areas related and relevant with healthcare and allied facilities are discussed and extracted from ECBC 2017.

Table 5.3.1: Interior Lighting Power for ECBC Buildings- Building Area Method as per ECBC 2017

SL. No.	Building Type	LPD (W/m2)
1	Convention center	12.5

Table 5.3.2: Interior Lighting Power for ECBC+ Buildings- Building Area Method as per ECBC 2017

SL. No.	Building Type	LPD (W/m2)
1	Convention center	10.0

Table 5.3.3: Interior Lighting Power for Super ECBC Buildings- Building Area Method as per ECBC 2017

SL. No	Building Type	LPD (W/m2)
1	Convention center	6.3

5.3.2: SPACE FUNCTION METHOD

Similar to building area method, the first step of the space function method is to identify the appropriate building type and their allowed lighting power densities, which varies according to the function of the space. In this section, the values of areas related with Convention center and allied facilities are discussed.

Table 5.3.4: Interior Lighting Power for ECBC Buildings – Space Function Method as per ECBC 2017

Area Category	LPD (W/m2)	Area Category	LPD (W/m2)
Common Space Types			
Restroom	7.7	Stairway	5.5
Storage	6.8	Corridor/Transition	7.1
Conference/ Meeting	11.5	Lobby	9.1
Parking Bays (covered/ basement)	2.2	Parking Driveways (covered/ basement)	3.0
Electrical/Mechanical	7.1	Workshop	17.1

Assembly			
Dressing Room	9.1	Seating Area – Performing Arts Theatre	22.6
Exhibit Space - Convention Centre	14.0	Lobby - Performing Arts Theatre	21.5
Seating Area - Gymnasium	4.6	Seating Area - Convention Centre	6.4
Fitness Area - Gymnasium	13.7	Seating Religious Building	16.4
Museum - General Exhibition	16.4	Playing Area - Gymnasium	18.8
Museum - Restoration	18.3		

Table 5.3.5: Interior Lighting Power for ECBC+ Buildings – Space Function Method as per ECBC 2017

Area Category	LPD (W/m2)	Area Category	LPD (W/m2)
Common Space Types			
Restroom	6.1	Stairway	4.4
Storage	5.4	Corridor/Transition	3.6
Conference/ Meeting	9.2	Lobby	7.3
Parking Bays (covered/ basement)	1.8	Parking Driveways (covered/ basement)	2.5
Electrical/Mechanical	5.7	Workshop	13.7
Assembly			
Dressing Room	7.3	Seating Area - Performing Arts Theatre	18.1
Exhibit Space - Convention Centre	11.2	Lobby - Performing Arts Theatre	17.2
Seating Area - Gymnasium	3.6	Seating Area - Convention Centre	5.1
Fitness Area - Gymnasium	7.9	Seating Religious Building	13.1
Museum - General Exhibition	11.3	Playing Area - Gymnasium	12.9
Museum - Restoration	11.0		

Table 5.3.6: Interior Lighting Power for Super ECBC Buildings – Space Function Method as per ECBC 2017

Area Category	**LPD (W/m2)**	**Area Category**	**LPD (W/m2)**
Common Space Types			
Restroom	3.8	Stairway	2.7
Storage	3.4	Corridor/Transition	2.3
Conference/ Meeting	5.7	Lobby	4.6
Parking Bays (covered/basement)	1.1	Parking Driveways (covered/ basement)	1.5
Electrical/Mechanical	3.5	Workshop	8.6
Assembly			
Dressing Room	4.6	Seating Area - Performing Arts Theatre	11.3
Exhibit Space - Convention Centre	7.0	Lobby - Performing Arts Theatre	10.8
Seating Area - Gymnasium	3.4	Seating Area - Convention Centre	3.2
Fitness Area - Gymnasium	3.9	Seating Religious Building	8.2
Museum - General Exhibition	5.7	Playing Area - Gymnasium	6.5
Museum - Restoration	5.5		

CHAPTER - 6: DESIGN DETAILS OF THE CASE STUDIES

6.1: INTRODUCTION:

The main objective of this chapter to demonstrate the simulation results of convention center and its allied areas, by using LED luminaires. The design illuminance follows the relevant codes and guidelines which are described in Chapter 5. The software used in these simulations is mainly by DIALux 4.13.

6.2: CASE STUDY ON CONVENTION CENTER ILLUMINATION DESIGN (SEMINAR TYPE):

Seminar type convention canter comprises of varied rooms with individual applications and its individual illumination requirements. So, illumination level and other criteria of all those individual rooms are to be met.

- The design must be glare free and friendly for the occupants.
- Reflectance factor of Ceiling, Wall and Floor are considered as 60%, 40% and 20% respectively as the indoor facility is quite clean and less dust accumulation.
- Maintenance Factor (MF) is considered as 0.80 for LED application.

The complete design is summarized in the design summary. The major areas are discussed below. DIALux 4.13 simulation results are as follows:

6.3: THE LUMINAIRE DETAILS WHICH ARE APPLIED FOR DESIGN SIMULATION ARE DESCRIBED BELOW:

i. LED 12-WATT ROUND SURFACED DOWNLIGHTER:

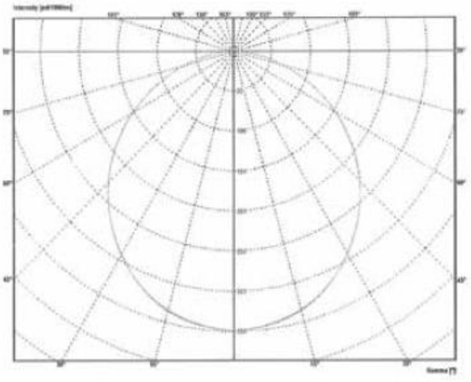


Fig6.3.1: LED 12-Watt round surfaced Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 1287 lm
Luminous flux (Lamps): 1287 lm
Luminaire Wattage: 11.5 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

ii. LED 30-WATT SQUARE 2X2 FT TILE RECESSED DOWNLIGHTER:

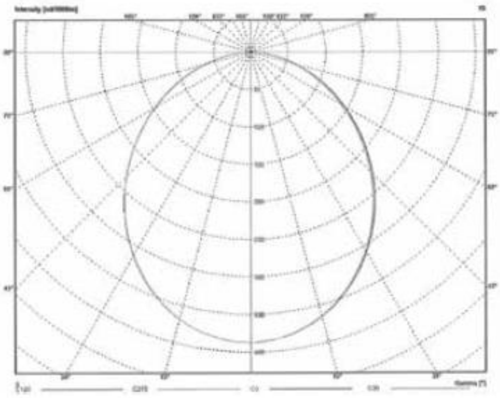


Fig6.3.2: LED 30-Watt square 2x2 ft tile recessed Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 3551 lm
Luminous flux (Lamps): 3553 lm
Luminaire Wattage: 31.5 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

iii. LED 24-WATT SPOT LIGHT:

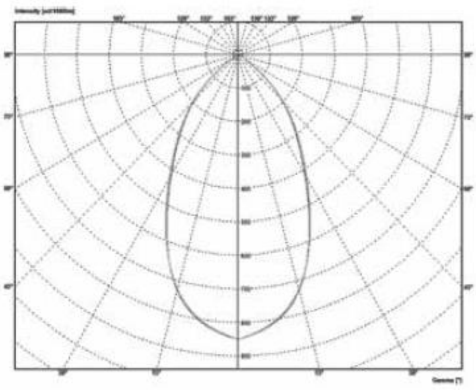


Fig6.3.3: LED 24-Watt spot light Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 230A±10
Luminous flux (Luminaire): 2570 lm
Luminous flux (Lamps): 2721 lm
Luminaire Wattage: 25.0 W
IP Rating: IP 20
CRI: >80
CCT: 4000K
Efficacy: >100 lm/W

iv. LED 18-WATT ROUND RECESSED DOWNLIGHTER:

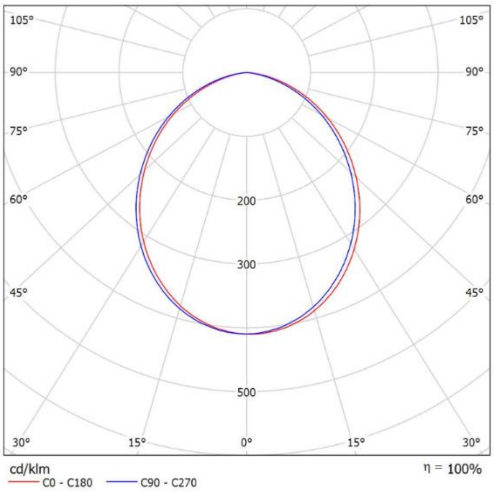


Fig6.3.4: LED 18-watt round recessed downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 1799 lm
Luminous flux (Lamps): 1800 lm
Luminaire Wattage: 18.5 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

6.4: DESIGN DETAILS OF THE CASE STUDIES:

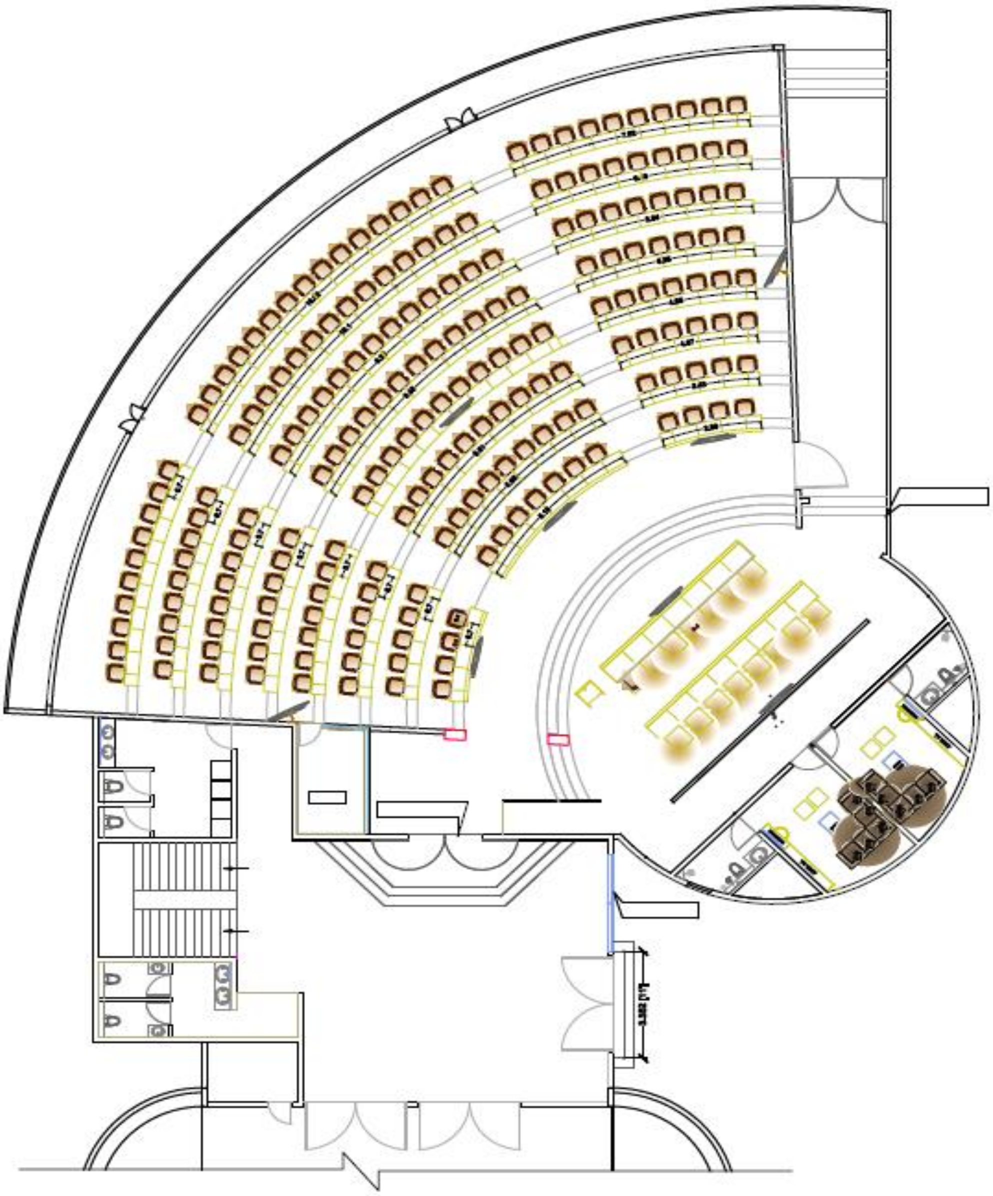
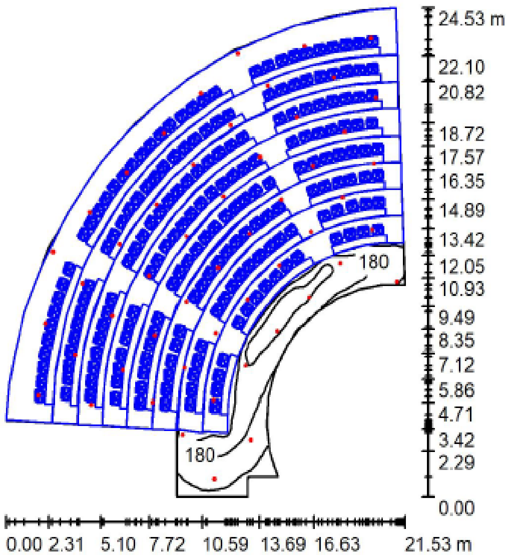


Fig 6.4.: Layout of floor plan of seminar type convention center

➢ **CONFERENCE HALL:** Theatre style conference hall used for product launch presentation displays used to present number of delegates. Design summary is furnished below.

CONFERENCE HALL / Summary



Height of Room: 6.750 m, Mounting Height: 6.750 m, Light loss factor: 0.80 Values in Lux, Scale 1:315

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	107	0.12	269	0.001
Floor	20	29	1.30	264	0.045
Ceiling	60	65	25	668	0.381
Walls (31)	40	57	5.73	3236	/

Workplane:
Height: 0.000 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.533, Ceiling / Working Plane: 0.606.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	52	Crompton Greaves Consumer Electricals Ltd 01 CDR-213-24-40-SL-NWH (1.000)	2570	2721	25.0
			Total: 133662	Total: 141497	1300.0

Specific connected load: 4.07 W/m² = 3.80 W/m²/100 lx (Ground area: 319.33 m²)

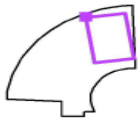
CONFERENCE HALL / Calculation Grid @ SECTION 1 / Value Chart (E, Perpendicular)

684	234	437	222	252	188	187	179
124	449	329	389	363	320	305	255
444	327	301	382	377	390	351	310
151	264	527	345	403	380	384	343
254	605	263	382	373	404	387	365

3.32 m / -3.32; -5.39 / 5.39 m

Values in Lux, Scale 1 : 78

Position of surface in room:
Marked point: (20.528 m, 35.366 m, 5.351 m)



Grid: 8 x 5 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
341	124	684	0.36	0.18

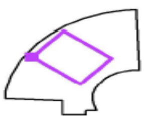
CONFERENCE HALL / Calculation Grid @ SECTION 2 / Value Chart (E, Perpendicular)

131	159	265	284	322	347	369	403	397	386	371
692	322	468	337	368	363	360	395	383	388	359
574	345	558	376	433	398	387	403	390	386	357
109	171	289	290	346	350	381	402	393	384	359
387	295	385	303	356	345	374	395	385	382	352
516	449	596	378	442	375	407	407	395	380	351
136	221	318	303	373	352	389	393	389	378	349
221	267	310	287	338	338	392	390	387	376	346
402	619	516	396	434	365	412	408	399	380	348

3.95 m / -3.95; -5.33 / 5.33 m

Values in Lux, Scale 1 : 77

Position of surface in room:
Marked point: (11.583 m, 27.114 m, 5.332 m)



Grid: 11 x 9 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
369	109	692	0.30	0.16

CONFERENCE HALL / Calculation Grid @ SECTION 3 / **Value Chart (E, Perpendicular)**

754	283	320	356	405	383	373
168	432	378	412	377	391	358
319	272	347	389	403	371	338
355	323	422	373	377	356	308
212	513	261	254	277	318	264

3.65 m

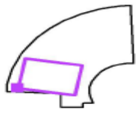
-3.65

-5.19

5.19 m

Values in Lux, Scale 1 : 75

Position of surface in room:
Marked point: (9.191 m, 18.073 m, 5.274 m)



Grid: 7 x 5 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
355	168	754	0.47	0.22

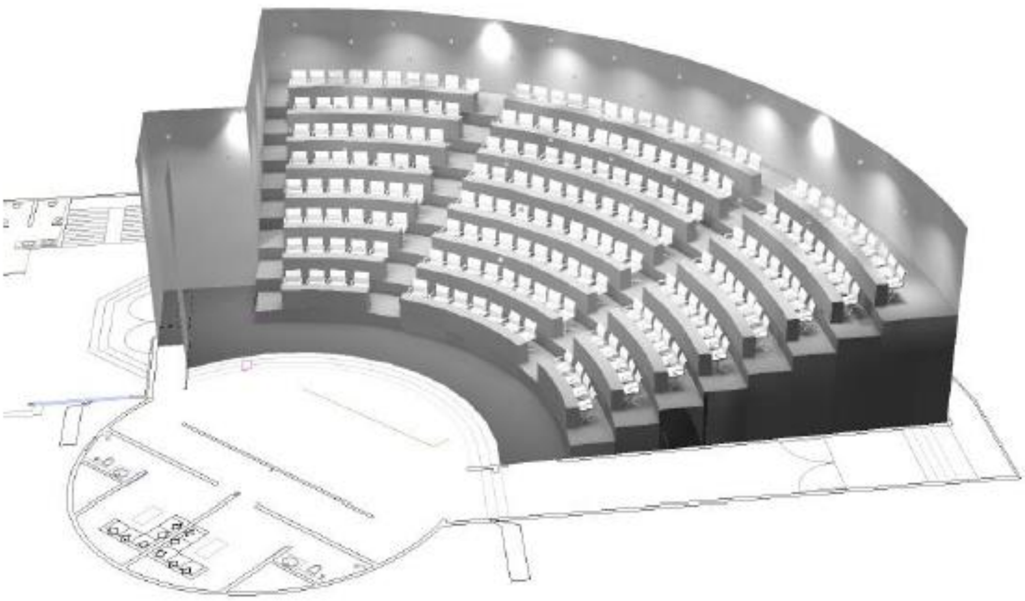


Fig 6.4.2: 3D Modelling of Conference Hall

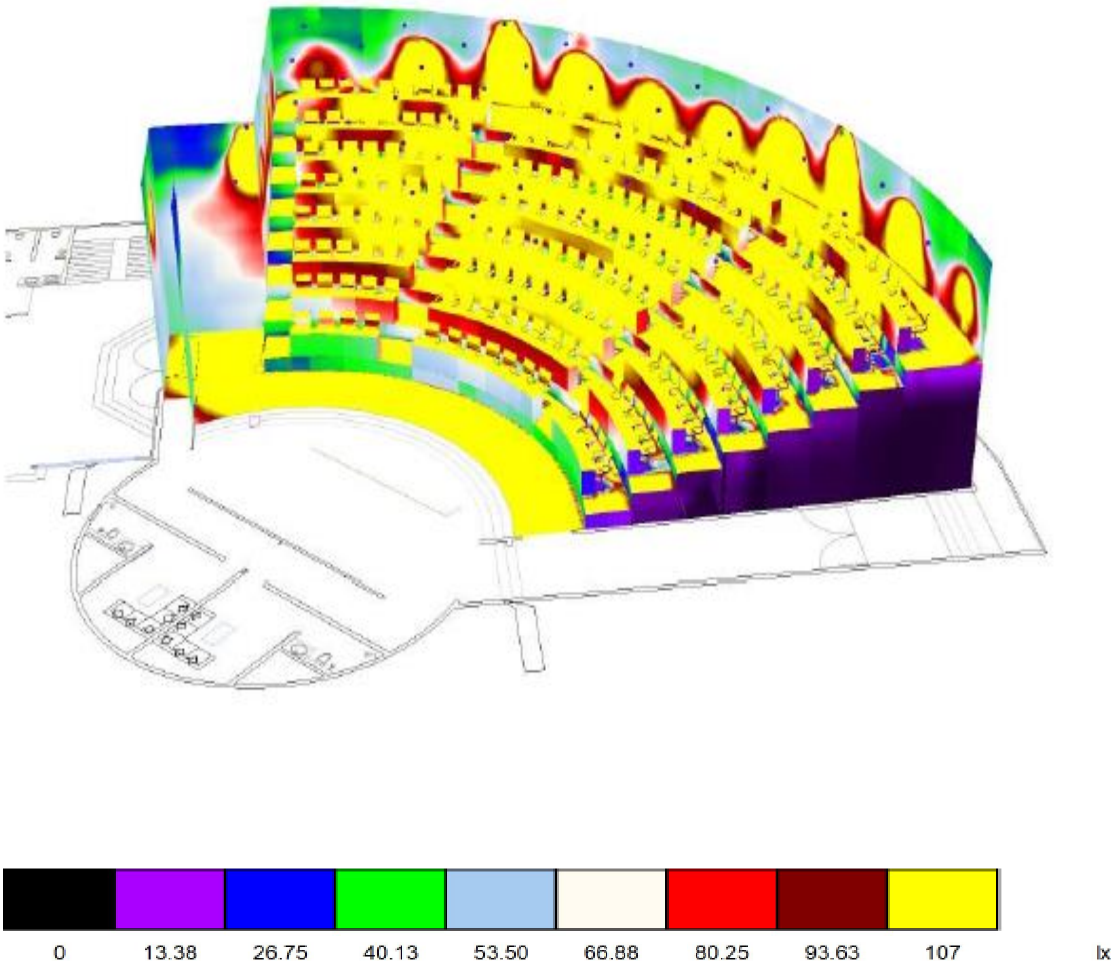
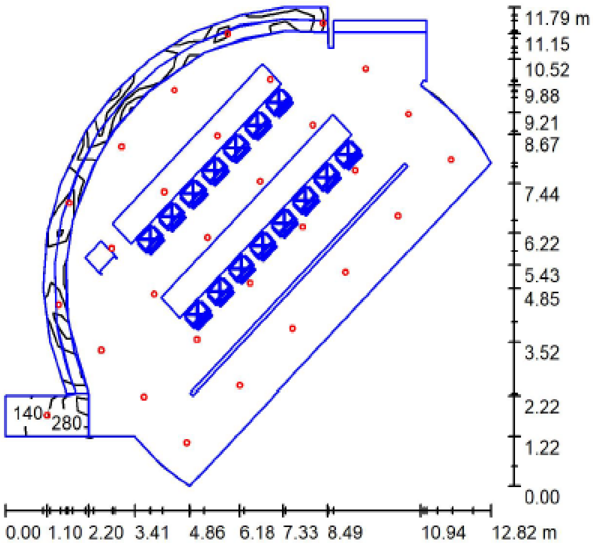


Fig 6.4.3: False Color Rendering of Conference Hall

➢ **STAGE AREA**: Stage is defined as to arrange, present or exhibit something that also combines music, spoken dialogue, and dance. Design summary is furnished below.

STAGE / Summary



Height of Room: 6.150 m, Mounting Height: 6.150 m, Light loss factor: 0.80 Values in Lux, Scale 1:152

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	317	117	417	0.368
Floor	20	2.78	0.37	49	0.134
Ceiling	60	76	39	747	0.519
Walls (29)	40	131	11	5638	/

Workplane:
Height: 0.450 m
Grid: 30 x 17 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.432, Ceiling / Working Plane: 0.240.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	29	Crompton Greaves Consumer Electricals Ltd 01 CDR-213-24-40-SL-NWH (1.000)	2570	2721	25.0
			Total: 74542	Total: 78912	725.0

Specific connected load: 8.19 W/m² = 2.59 W/m²/100 lx (Ground area: 88.48 m²)

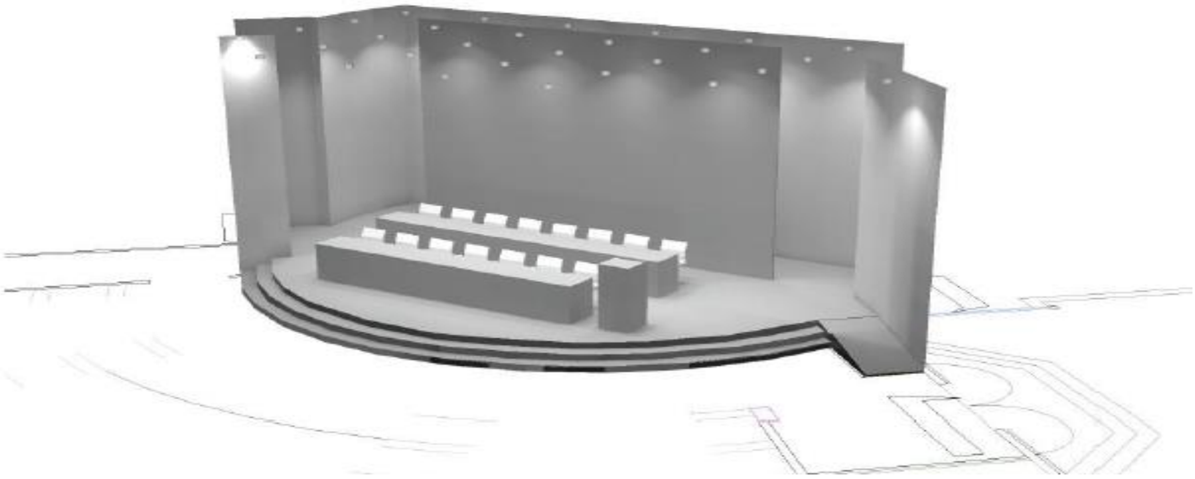


Fig 6.4.4: 3D Modelling of Stage Area

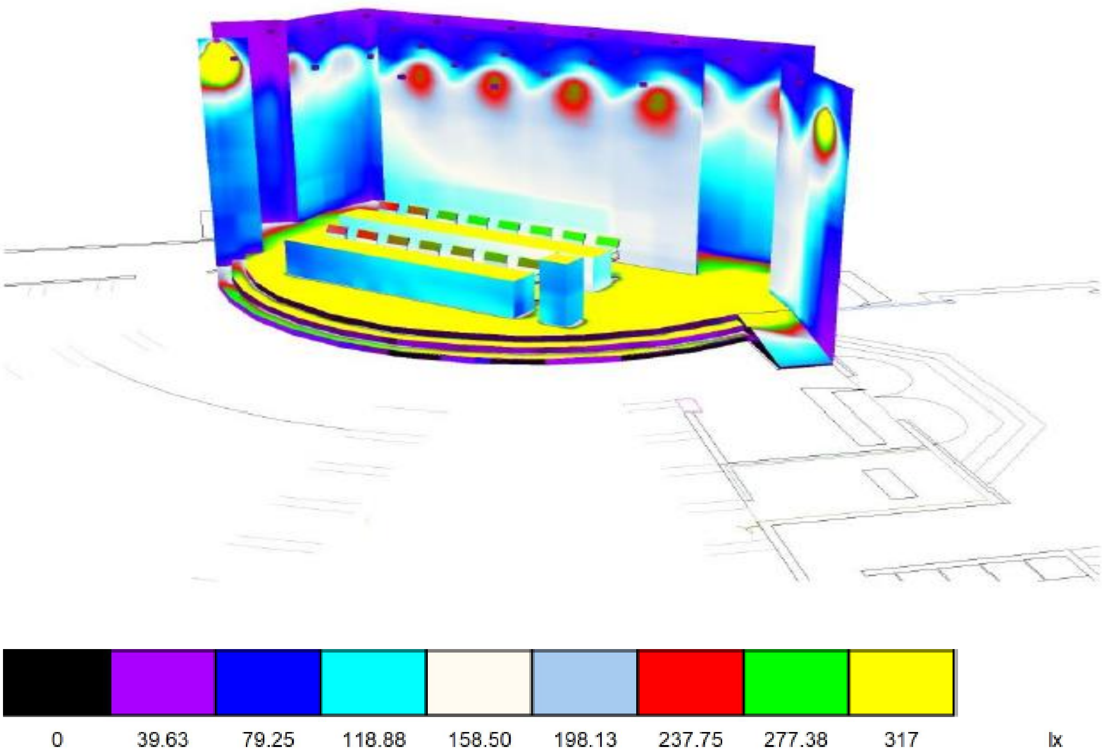
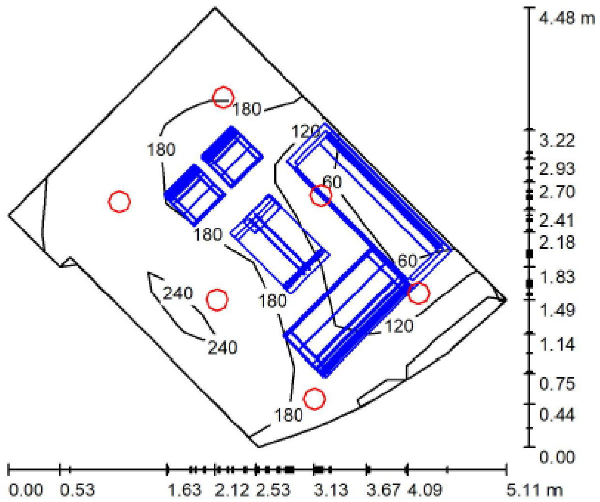


Fig 6.4.5: False colour rendering of Stage

➢ **GREEN ROOM**: The green room is the space in a theatre or similar venue that functions as a waiting room and lounge for performers before, during, and after a performance or show when they are not engaged on stage. Green rooms typically have seating for the performers, such as upholstered chairs and sofas. Design summary is furnished below.

GENTS GREEN ROOM / Summary



Height of Room: 3.500 m, Mounting Height: 3.500 m, Light loss factor: 0.80 Values in Lux, Scale 1:58

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	166	14	268	0.085
Floor	20	167	13	269	0.080
Ceiling	60	84	55	140	0.658
Walls (9)	40	204	11	1866	/

Workplane:

Height:	0.000 m
Grid:	8 x 5 Points
Boundary Zone:	0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 1.230, Ceiling / Working Plane: 0.503.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	6	Crompton Greaves Ltd. 01 LCDEP-18-CDL (1.000)	1799	1800	18.5
			Total: 10794	Total: 10800	111.0

Specific connected load: 9.69 W/m² = 5.79 W/m²/100 lx (Ground area: 11.45 m²)

Fig 6.4.6: 3D Modelling of Green Room

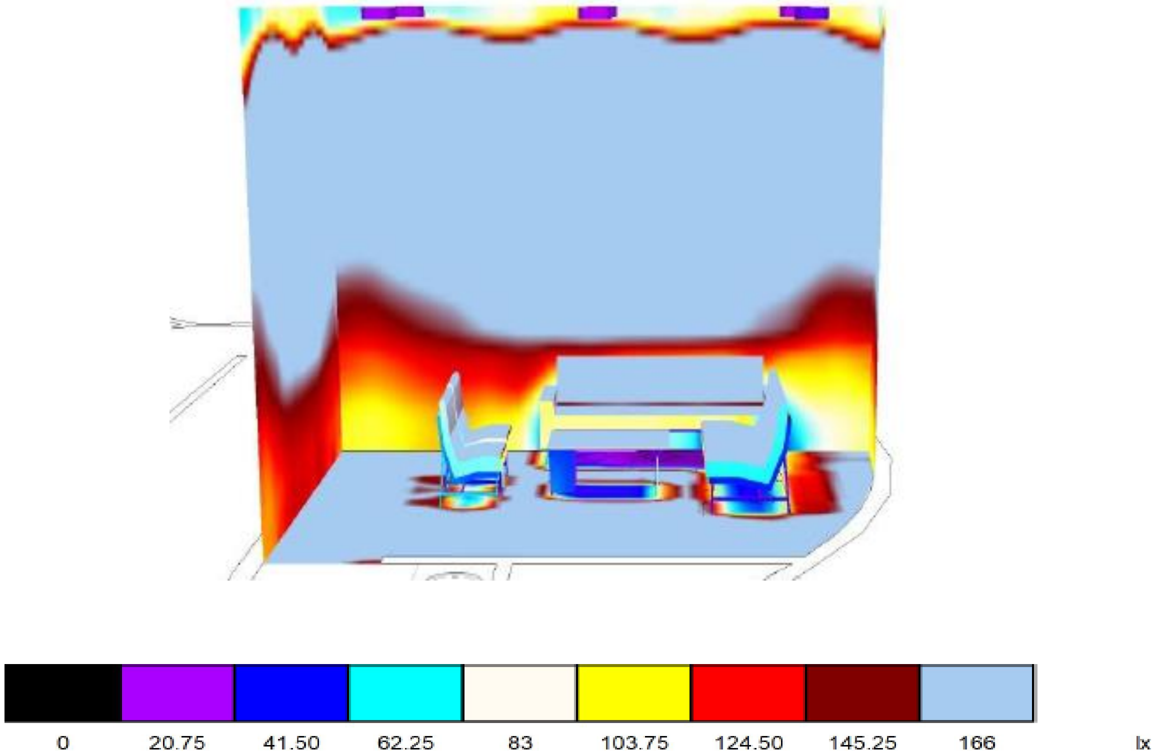
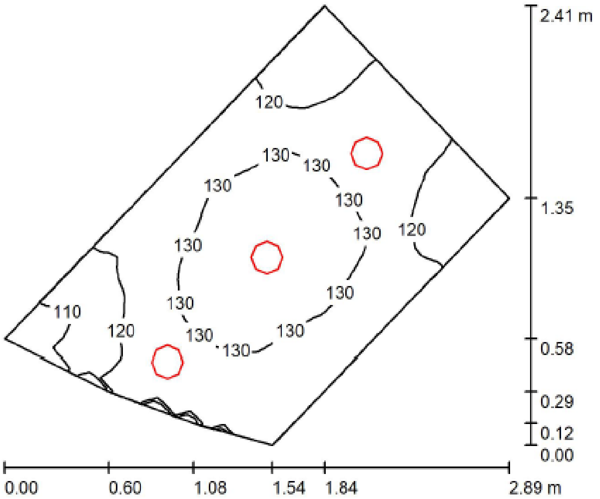


Fig 6.4.7: False color Rendering of Green Room

➢ **TOILET:** A room with washing and toilet facilities. Design summary is furnished below.

TOI_GENTS GREEN ROOM / Summary



Height of Room: 3.250 m, Mounting Height: 3.250 m, Light loss factor: 0.80 Values in Lux, Scale 1:31

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	125	106	137	0.845
Floor	20	125	104	137	0.836
Ceiling	60	112	59	1278	0.530
Walls (6)	40	171	45	1579	/

Workplane:

Height: 0.000 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 1.371, Ceiling / Working Plane: 0.899.

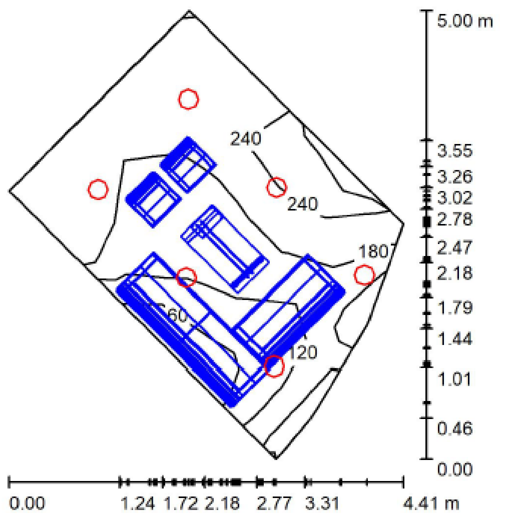
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	Crompton Greaves Consumer Electricals Ltd 01 LCDSPLN-R-12-CDL (1.000)	1287	1287	11.5
			Total: 3861	Total: 3860	34.5

Specific connected load: 10.08 W/m² = 8.07 W/m²/100 lx (Ground area: 3.42 m²)

- **GREEN ROOM**: The green room is the space in a theatre or similar venue that functions as a waiting room and lounge for performers before, during, and after a performance or show when they are not engaged on stage. Design summary is furnished below.

LADIES GREEN ROOM / Summary



Height of Room: 3.500 m, Mounting Height: 3.500 m, Light loss factor: 0.80 Values in Lux, Scale 1:65

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	174	15	267	0.086
Floor	20	170	14	273	0.080
Ceiling	60	85	64	171	0.753
Walls (6)	40	209	11	3150	/

Workplane:
Height: 0.000 m
Grid: 8 x 5 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 1.235, Ceiling / Working Plane: 0.502.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	6	Crompton Greaves Ltd. 01 LCDEP-18-CDL (1.000)	1799	1800	18.5
			Total: 10794	Total: 10800	111.0

Specific connected load: 9.93 W/m² = 5.72 W/m²/100 lx (Ground area: 11.18 m²)

Fig 6.4.8: 3D Modelling of Green Room

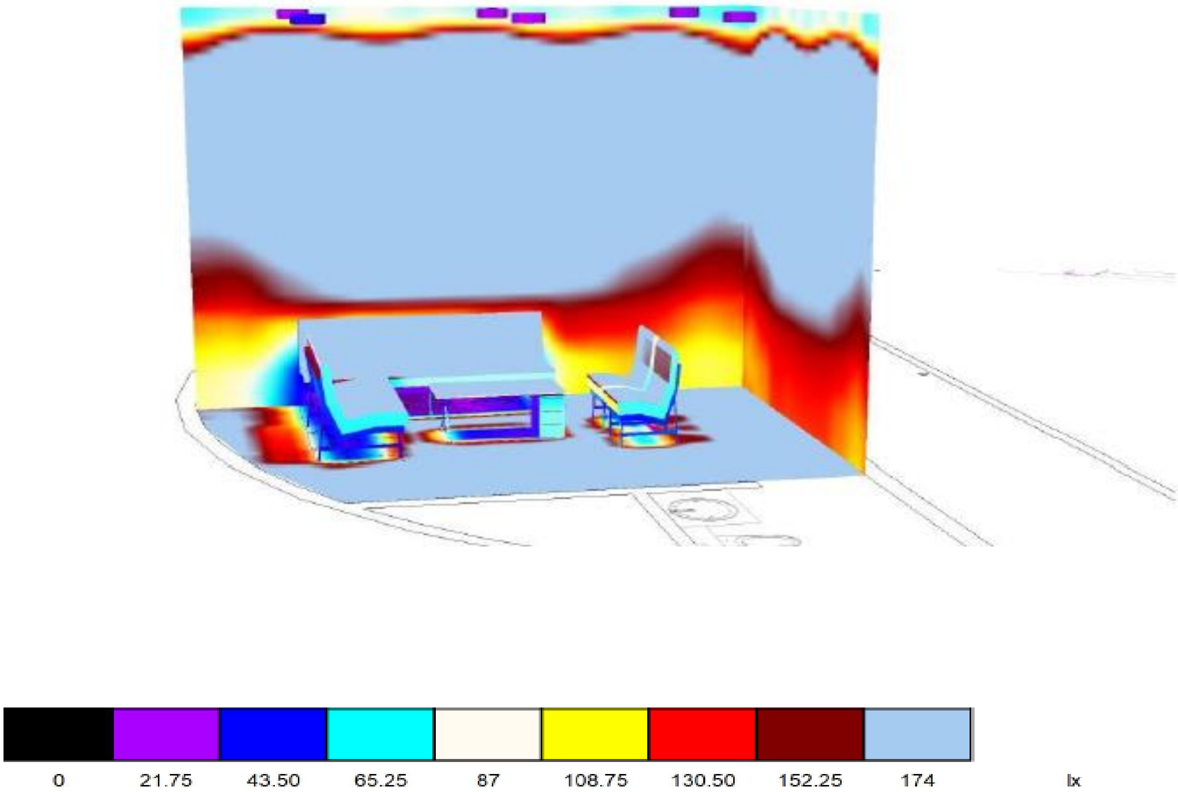
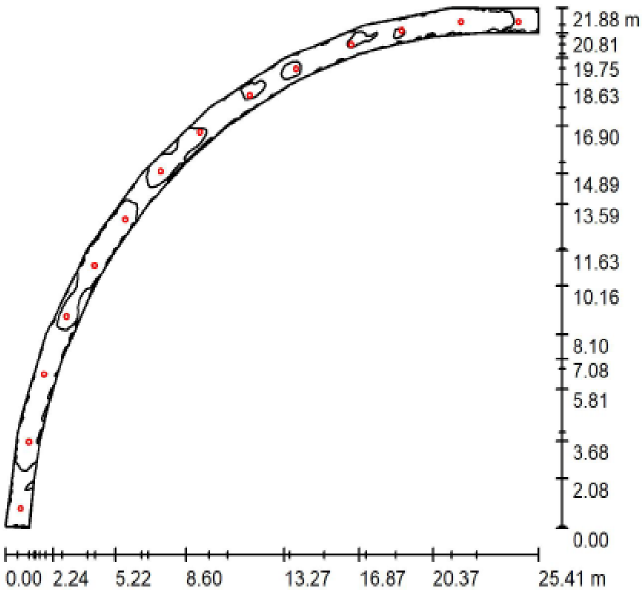


Fig 6.4.9: False Color Rendering of Green Room

- **PASSAGE:** A narrow way allowing access between buildings or to different rooms within a building; a passageway. Design summary is furnished below.

PASSAGE / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:281

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	133	96	149	0.719
Floor	20	133	94	151	0.705
Ceiling	60	48	30	117	0.630
Walls (29)	40	112	37	677	/

Workplane:

Height: 0.000 m
Grid: 128 x 64 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.840, Ceiling / Working Plane: 0.358.

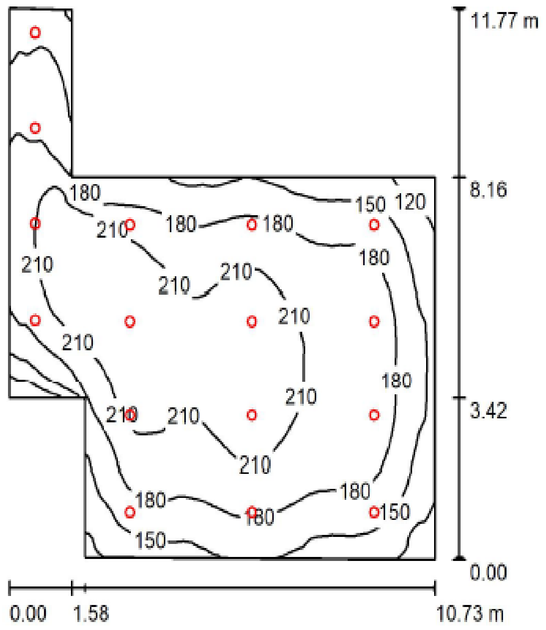
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	14	Crompton Greaves Ltd. 01 LCDEP-18-CDL (1.000)	1799	1800	18.5
			Total: 25186	Total: 25200	259.0

Specific connected load: 6.55 W/m² = 4.91 W/m²/100 lx (Ground area: 39.54 m²)

- **ENTRANCE LOBBY:** The entrance lobby is a room in a building used for entry from the outside. Sometimes referred to as a foyer, reception area or an entrance hall, it is often a large room or complex of rooms (in a theatre, opera house, concert hall, showroom, cinema, etc.) adjacent to the auditorium. Design summary is furnished below.

ENTRANCE LOBBY / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:152

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	185	95	234	0.513
Floor	20	185	94	234	0.510
Ceiling	60	39	30	72	0.754
Walls (8)	40	110	30	576	/

Workplane:
Height: 0.000 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.591, Ceiling / Working Plane: 0.212.

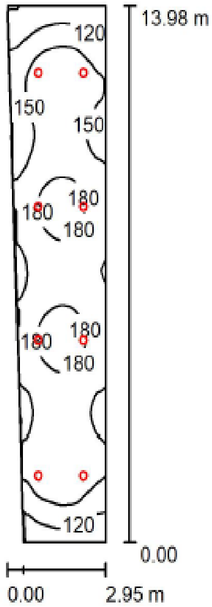
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	16	Crompton Greaves Ltd. 01 LCDEP-18-CDL (1.000)	1799	1800	18.5
			Total: 28784	Total: 28800	296.0

Specific connected load: 3.43 W/m² = 1.85 W/m²/100 lx (Ground area: 86.40 m²)

➢ **EXIT AREA:** A departure from a stage. Design summary is furnished below.

EXIT AREA / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:180

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	157	87	194	0.558
Floor	20	157	88	194	0.562
Ceiling	60	37	25	57	0.681
Walls (4)	40	102	25	583	/

Workplane:
Height: 0.000 m
Grid: 32 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.646, Ceiling / Working Plane: 0.233.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)		Φ (Luminaire) [lm]		Φ (Lamps) [lm]	P [W]
1	8	Crompton Greaves Ltd. 01 LCDEP-18-CDL (1.000)		1799		1800	18.5
			Total:	14392	Total:	14400	148.0

Specific connected load: 3.92 W/m² = 2.50 W/m²/100 lx (Ground area: 37.78 m²)

6.5: DESIGN SUMMARY AND BILL OF MATERIALS OF THE DESIGN:

SL. No	Room name	Average Illumination level (lx)	Type and Wattage of Luminaire (W)	Quantity	Floor area (m2)	LPD (W/m2)
1	CONFERENCE HALL	355	LED 24-Watt spot light Downlighter	52	319.33	4.07
2	STAGE	317	LED 24-Watt spot light Downlighter	29	88.48	8.19
3	GENTS GREEN ROOM	166	LED 18 W RECESSED DOWLIGHTER	6	11.45	9.69
4	TOI_GENTS GREEN ROOM	125	LED 12 W SURFACED DOWLIGHTER	3	3.42	10.08
5	LADIES GREEN ROOM	174	LED 18 W RECESSED DOWLIGHTER	6	11.18	9.93
6	TOI_LADIES GREEN ROOM	127	LED 12 W SURFACED DOWLIGHTER	3	3.21	10.75
7	EXIT AREA	157	LED 18 W RECESSED DOWLIGHTER	8	37.78	3.92
8	PASSAGE	133	LED 18 W RECESSED DOWLIGHTER	14	39.54	6.55
9	CONTROL ROOM	327	LED 30 W 2X2 TILE RECESSED DOWLIGHTER	2	6.39	9.86
10	ENTRANCE LOBBY	185	LED 18 W RECESSED DOWLIGHTER	16	86.40	3.43
11	EXISTING TOILET 1	115	LED 12 W SURFACED DOWLIGHTER	6	14.17	4.87
12	EXISTING TOILET 2	103	LED 12 W SURFACED DOWLIGHTER	6	11.57	5.96

6.6: CASE STUDY ON CONVENTION CENTER ILLUMINATION DESIGN (ALL PURPOSE TYPE):

A convention center is designed for the purpose of conducting meetings, conferences, exhibitions and seminars. In this section a newly launched project that has been coming up with modern facilities situated at south India.
The convention center comprised of ground, first floor. The design details are as follows:

6.7: THE LUMINAIRE DETAILS WHICH ARE APPLIED FOR DESIGN SIMULATION (GROUND, FIRST FLOOR) ARE DESCRIBED BELOW:

i. LED 12-WATT ROUND SURFACED DOWNLIGHTER:

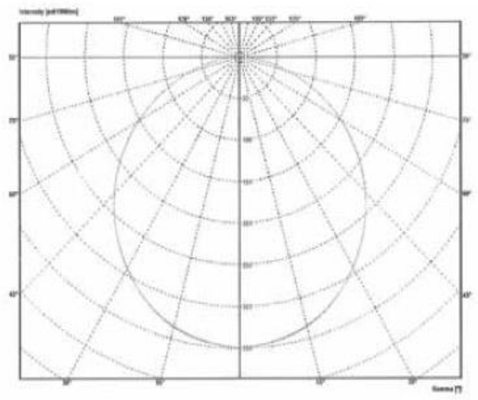


Fig.6.7.1: LED 12-Watt round surfaced Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 1287 lm
Luminous flux (Lamps): 1287 lm
Luminaire Wattage: 11.5 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

ii. LED 18-WATT ROUND SURFACED DOWNLIGHTER:

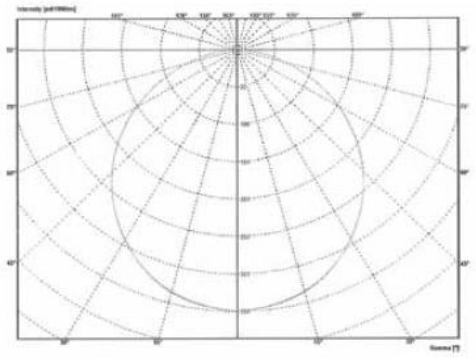



Fig.6.7.2: LED 18-Watt round surfaced Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 1716 lm
Luminous flux (Lamps): 1715 lm
Luminaire Wattage: 16.8 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

iii. LED 36-WATT SQUARE 2X2 FT TILE SURFACED DOWNLIGHTER:

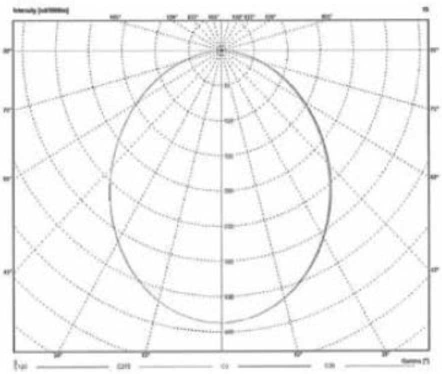



Fig.6.7.3: LED 36-Watt square 2x2 ft tile surfaced Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 3740 lm
Luminous flux (Lamps): 3783 lm
Luminaire Wattage: 37.3 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

iv. LED 36-WATT SQUARE 2X2 FT TILE RECESSED DOWNLIGHTER:

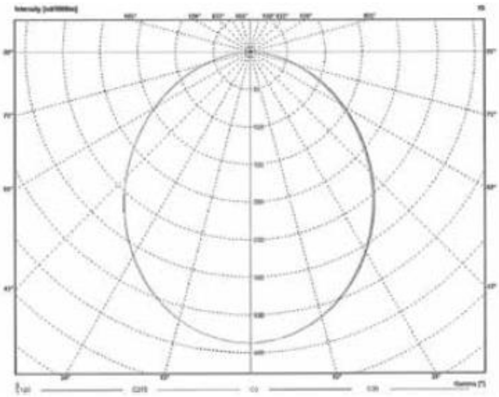
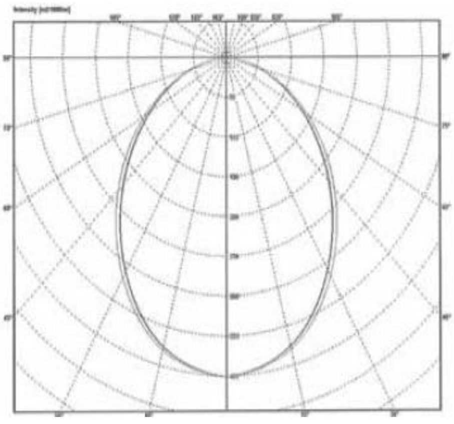


Fig.6.7.4: LED 36-Watt square 2x2 ft tile recessed Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 3906 lm
Luminous flux (Lamps): 3946 lm
Luminaire Wattage: 34.2 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

v. LED 36-WATT SUSPENDED LINEAR DOWNLIGHTER:



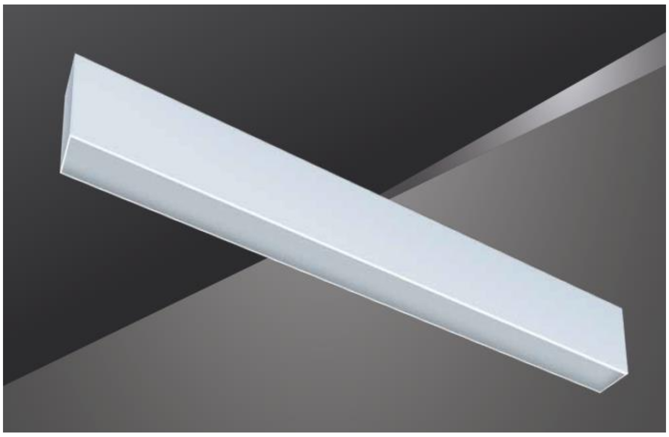


Fig.6.7.5: LED 36-Watt suspended linear Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 3509 lm
Luminous flux (Lamps): 3511 lm
Luminaire Wattage: 33.8 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

vi. LED 40-WATT BATTEN DOWNLIGHTER:

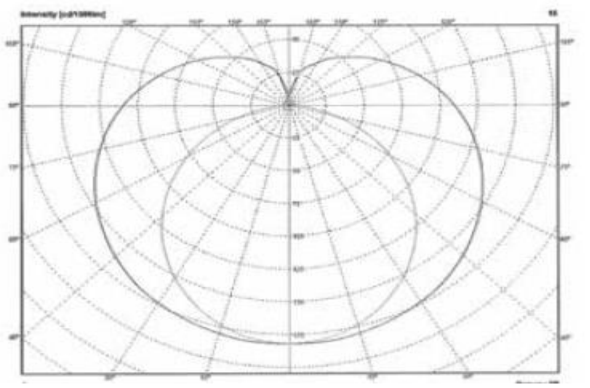


Fig.6.7.6: LED 40-Watt batten Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 240 V
Luminous flux (Luminaire): 4000 lm
Luminous flux (Lamps): 4000 lm
Luminaire Wattage: 40.0 W
IP Rating: IP 20
CRI: >80
CCT: 5700K
Efficacy: >100 lm/W

vii. LED 24-WATT SPOT LIGHT:

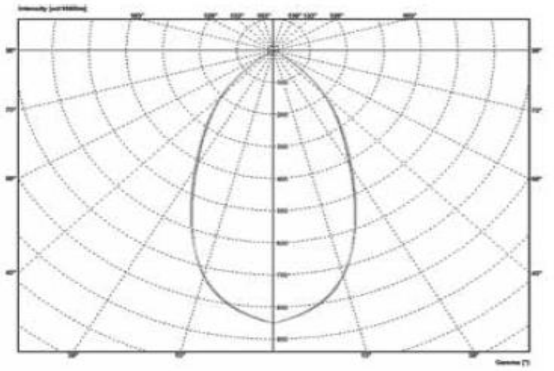


Fig.6.7.7:24-Watt spot light Downlighter Polar Curve and physical appearance

Technical specification:
Nominal Voltage: 230A±10
Luminous flux (Luminaire): 2570 lm
Luminous flux (Lamps): 2721 lm
Luminaire Wattage: 25.0 W
IP Rating: IP 20
CRI: >80
CCT: 4000K
Efficacy: >100 lm/W

6.8: GROUND FLOOR SIMULATION DESIGN DETAILS:

Fig.6.8.1: Layout of Ground Floor Plan of Convention Center

6.9: THE DESIGN CONSIDERATIONS ARE:

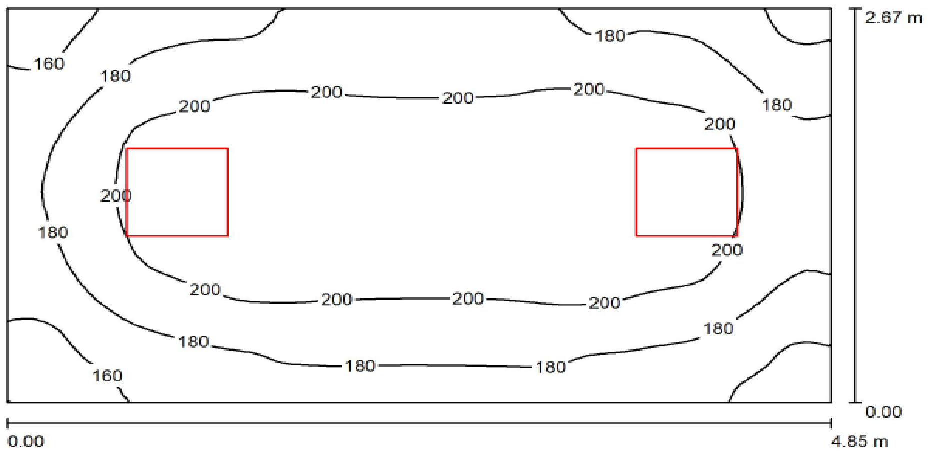
Ground floor of the convention center comprised of varied rooms with individual applications and its individual illumination requirements. So, illumination level and other criteria of all those individual rooms are to be met.

- The design must be glare free and friendly for the occupants.
- Reflectance factor of Ceiling, Wall and Floor are considered as 70%, 50% and 20% respectively as the indoor facility is quite clean and less dust accumulation.
- Maintenance Factor (MF) is considered as 0.80 for LED application.

The complete design of the ground floor is summarized in the design summary. The major areas in the ground floors are discussed below. DIALux 4.13 simulation results are as follows:

- **TICKET COUNTER**: The place to buy a ticket for theatre, cinema, etc. Design summary is furnished below.

TICKET COUNTER / Summary



Height of Room: 3.885 m, Mounting Height: 3.885 m, Light loss factor: 0.80 | Values in Lux, Scale 1:35

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	191	139	218	0.728
Floor	20	152	120	171	0.790
Ceiling	70	64	35	95	0.543
Walls (4)	50	139	60	473	/

Workplane:
Height: 0.760 m
Grid: 32 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.803, Ceiling / Working Plane: 0.337.

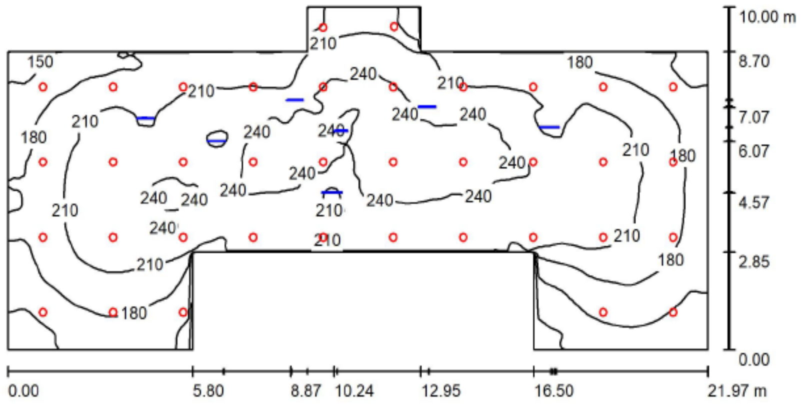
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 7480	Total: 7567	74.6

Specific connected load: 5.76 W/m² = 3.01 W/m²/100 lx (Ground area: 12.96 m²)

- **WAITING LOBBY**: A room providing a space out of which one or more other rooms or corridors lead, typically one near the entrance of a public building. Design summary is furnished below.

WAITING LOBBY / **Summary**



Height of Room: 3.885 m, Mounting Height: 3.885 m, Light loss factor: 0.80 Values in Lux, Scale 1:158

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	205	111	259	0.541
Floor	20	205	106	258	0.515
Ceiling	70	66	38	2032	0.581
Walls (12)	50	143	53	1570	/

Workplane:
Height: 0.000 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.697, Ceiling / Working Plane: 0.321.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	37	Crompton Greaves Consumer Electricals Ltd 01 LCDSPLN-R-18-CDL (1.000)	1716	1715	16.8
			Total: 63484	Total: 63462	621.6

Specific connected load: 3.76 W/m² = 1.83 W/m²/100 lx (Ground area: 165.24 m²)

Fig.6.9.1:3D Modelling of Waiting Lobby

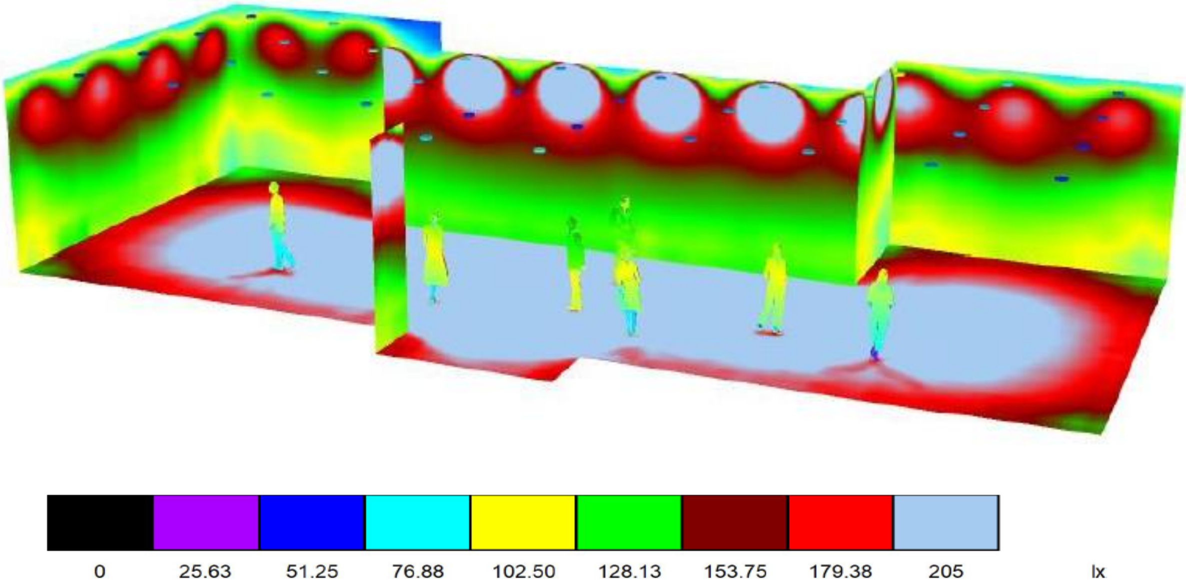
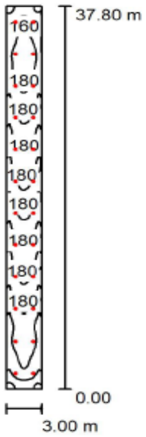


Fig. 6.9.2: False Color Rendering of Waiting Lobby

- **CORRIDOR**: A long passage in a building from which doors lead into rooms. Design summary is furnished below.

CORRIDOR 1 / Summary



Height of Room: 3.150 m, Mounting Height: 3.150 m, Light loss factor: 0.80 — Values in Lux, Scale 1:486

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	164	111	184	0.676
Floor	20	165	113	185	0.687
Ceiling	70	60	42	1364	0.696
Walls (4)	50	122	49	322	/

Workplane:

Height:	0.000 m
Grid:	128 x 32 Points
Boundary Zone:	0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.745, Ceiling / Working Plane: 0.365.

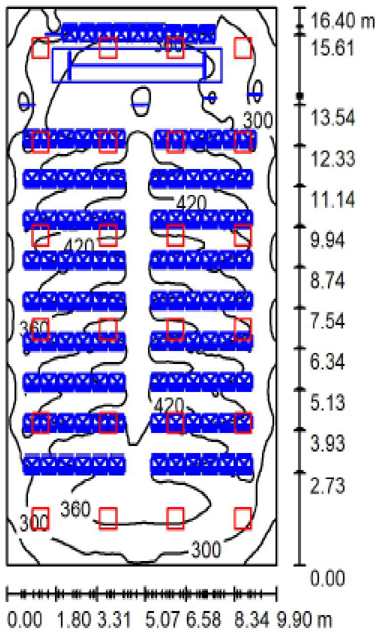
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	24	Crompton Greaves Consumer Electricals Ltd 01 LCDSPLN-R-18-CDL (1.000)	1716	1715	16.8
			Total: 41179	Total: 41165	403.2

Specific connected load: 3.58 W/m² = 2.18 W/m²/100 lx (Ground area: 112.78 m²)

- **SEMINAR ROOM**: A seminar room is a place where meetings are organized to inform a group of people about a specific topic, or to teach a specific skill. Expert speakers and teachers are usually speaking on various topics. Design summary is furnished below.

SEMINAR ROOM / Summary



Height of Room: 3.850 m, Mounting Height: 3.850 m, Light loss factor: 0.80

Values in Lux, Scale 1:211

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	357	178	450	0.498
Floor	20	225	49	370	0.219
Ceiling	70	88	66	127	0.745
Walls (4)	50	206	86	347	/

Workplane:

Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.606, Ceiling / Working Plane: 0.247.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	24	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 89756	Total: 90802	895.2

Specific connected load: 5.51 W/m² = 1.54 W/m²/100 lx (Ground area: 162.36 m²)

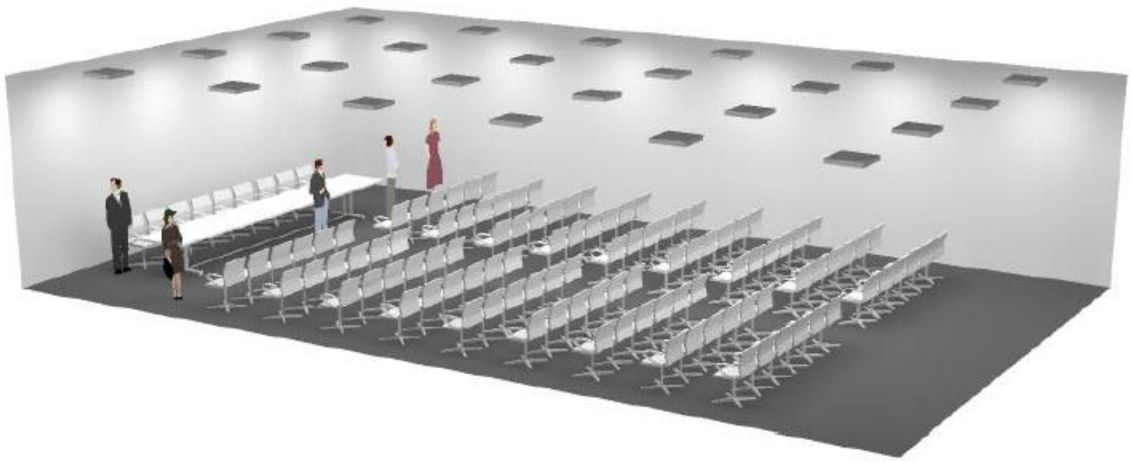


Fig. 6.9.3:3D Modelling of Seminar Room

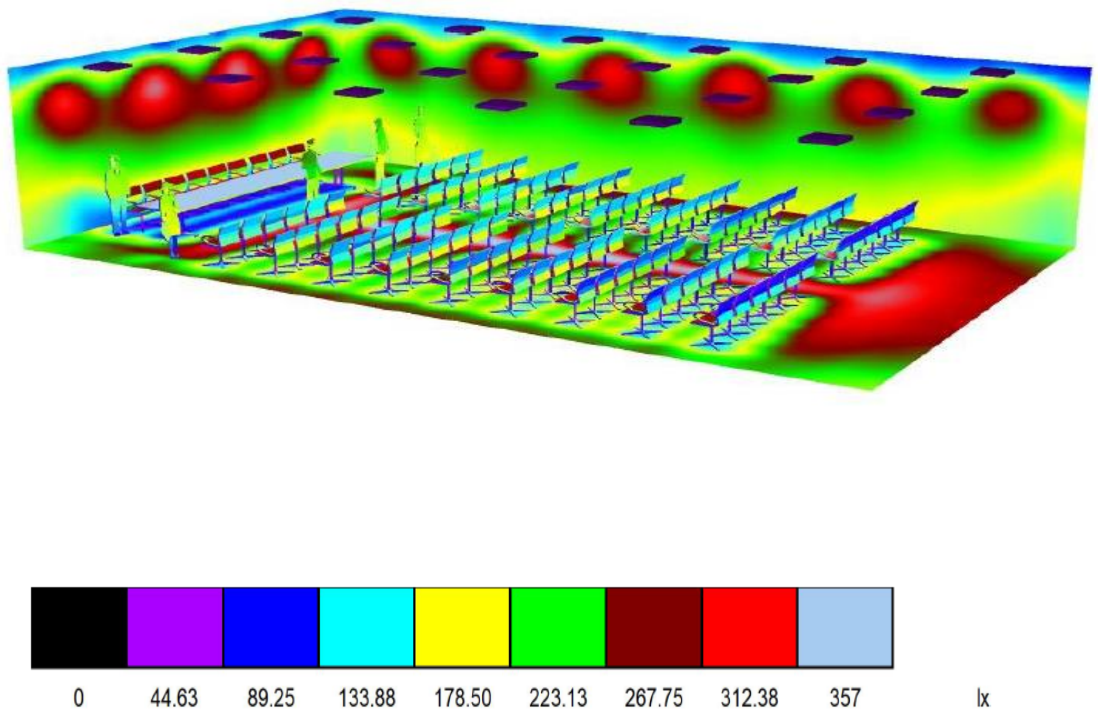
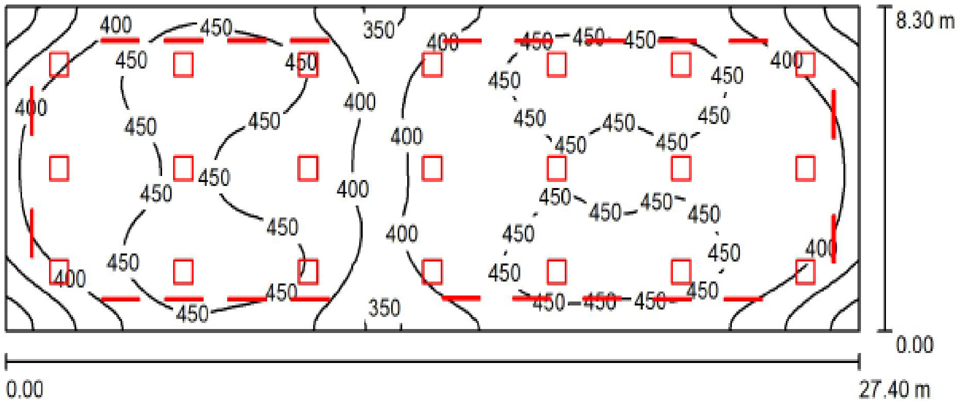


Fig. 6.9.4: False Colour Rendering of Seminar Room

- **EXHIBITION SPACE**: A place where exhibitions are usually organized so that organizations in a specific interest or industry can showcase and demonstrate their latest products, service, study activities of rivals and examine recent trends and opportunities. Design summary is furnished below.

EXHIBITION SPACE / Summary



Height of Room: 3.850 m, Light loss factor: 0.80 — Values in Lux, Scale 1:196

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	426	267	492	0.627
Floor	20	425	276	491	0.648
Ceiling	70	103	77	142	0.747
Walls (4)	50	273	100	623	/

Workplane:

Height:	0.000 m
Grid:	64 x 32 Points
Boundary Zone:	0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.639, Ceiling / Working Plane: 0.241.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	21	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
2	22	Crompton Greaves Ltd. 01 LCLP54-36-CDL (1.000)	3509	3511	33.8
			Total: 155738	Total: 156696	1525.8

Specific connected load: 6.71 W/m² = 1.58 W/m²/100 lx (Ground area: 227.42 m²)

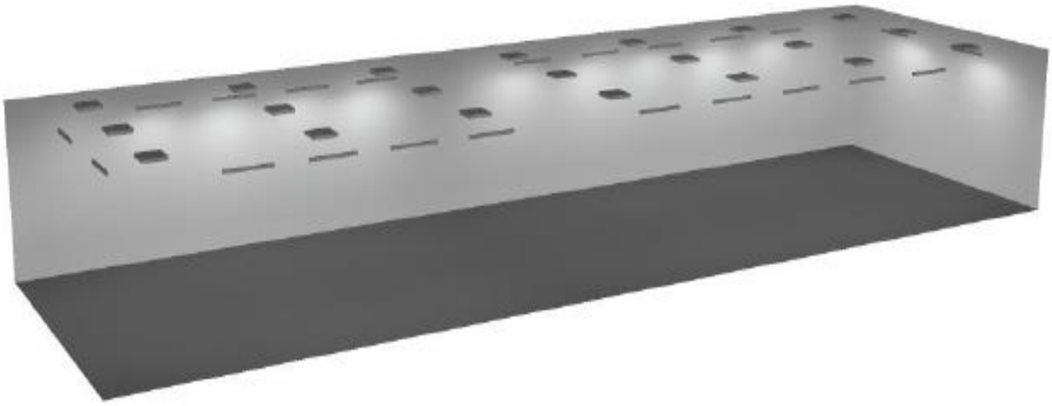


Fig. 6.9.5:3D Modelling of Exhibition Space

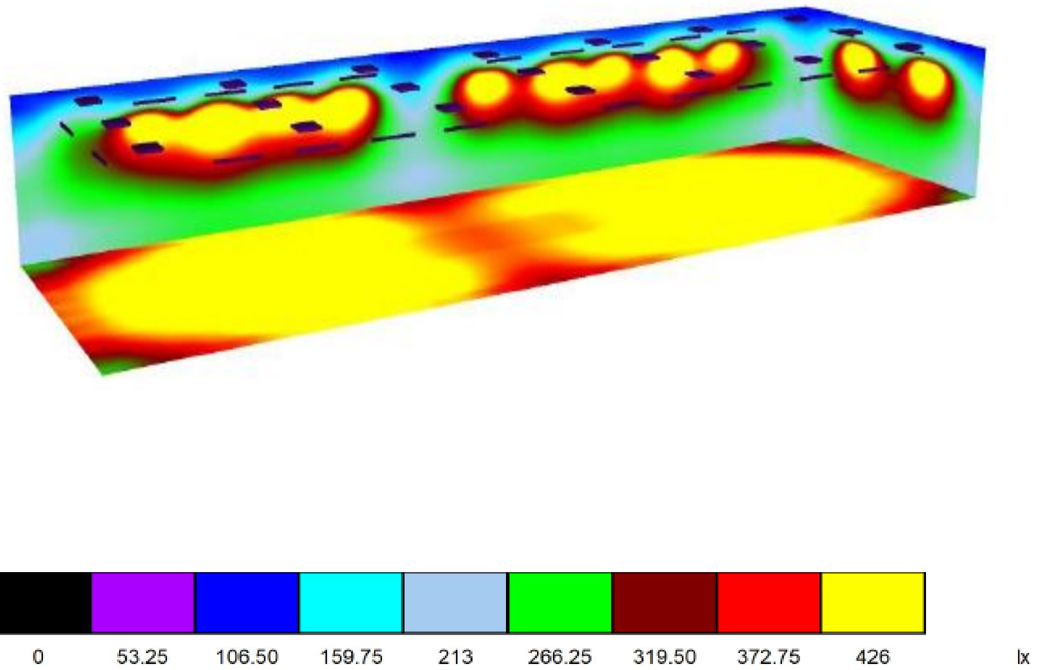
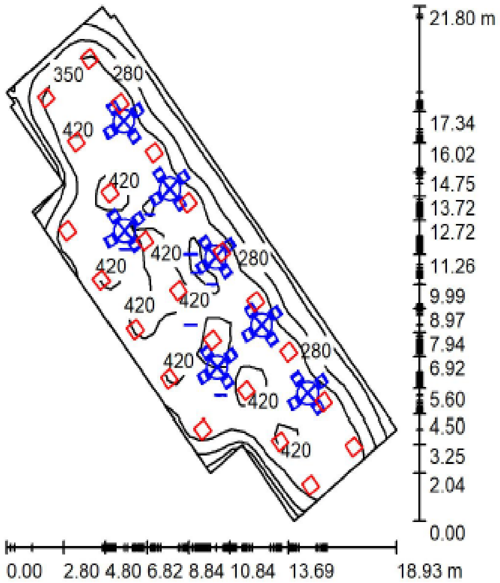


Fig. 6.9.6: False Colour Rendering of Exhibition Space

➢ **CAFETERIA**: Cafeteria is a place where there is little to no staff and has mostly self-service counters. a restaurant in which customers serve themselves from a counter and pay before eating. Design summary is furnished below.

CAFETERIA / Summary



Height of Room: 3.100 m, Mounting Height: 3.100 m, Light loss factor: 0.80 — Values in Lux, Scale 1:280

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	357	159	461	0.446
Floor	20	301	89	411	0.295
Ceiling	70	75	55	150	0.737
Walls (12)	50	185	62	663	/

Workplane:

Height:	0.760 m
Grid:	46 x 17 Points
Boundary Zone:	0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.518, Ceiling / Working Plane: 0.211.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	23	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 86016	Total: 87018	857.9

Specific connected load: 5.00 W/m² = 1.40 W/m²/100 lx (Ground area: 171.70 m²)

Fig. 6.9.7: 3D Modelling of Cafeteria

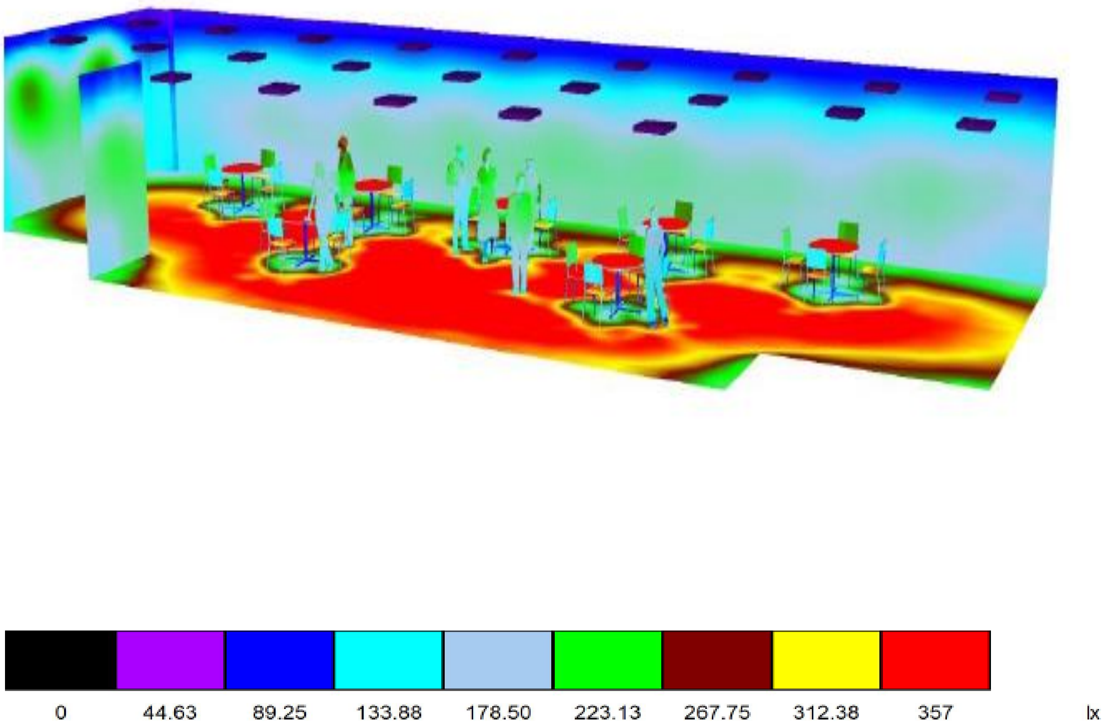
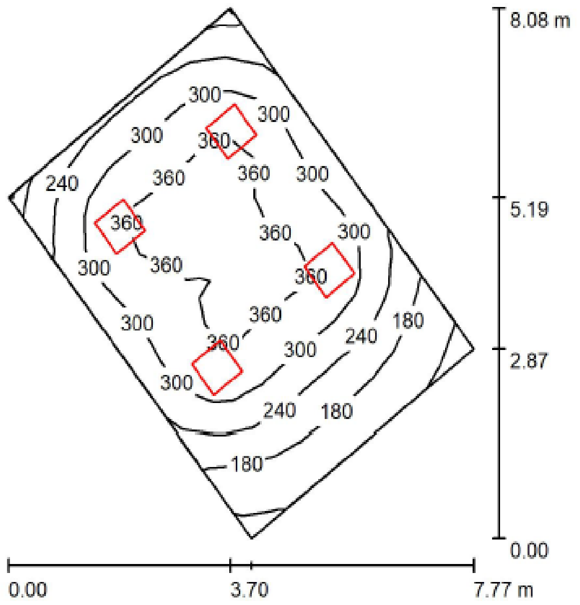


Fig. 6.9.8: False Colour Rendering of Cafeteria

➢ **KITCHEN**: A kitchen is a room or part of a room used for cooking and food preparation in a dwelling or in a commercial establishment. Design summary is furnished below.

KITCHEN / Summary



Height of Room: 3.100 m, Mounting Height: 3.100 m, Light loss factor: 0.80 — Values in Lux, Scale 1:104

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	285	111	383	0.391
Floor	20	241	122	316	0.507
Ceiling	70	62	41	96	0.653
Walls (4)	50	151	50	308	/

Workplane:
Height: 0.760 m
Grid: 13 x 9 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.552, Ceiling / Working Plane: 0.218.

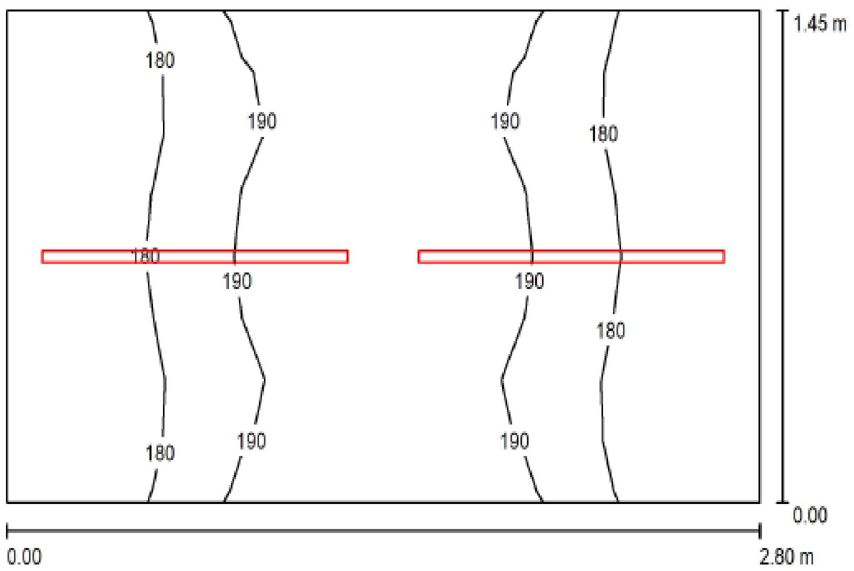
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 14959	Total: 15134	149.2

Specific connected load: 4.81 W/m² = 1.69 W/m²/100 lx (Ground area: 31.01 m²)

➢ **ELECTRICAL ROOM:** Distribution panels, Branch circuit panels, and low-voltage transformers are typically located in these spaces and directly serve the end-user loads: lighting, receptacles, and small equipment. Lighting control system panels and devices (and other electrical system devices) are sometimes also located in these rooms. Design summary is furnished below.

ELECTRICAL ROOM / Summary



Height of Room: 3.885 m, Mounting Height: 3.885 m, Light loss factor: 0.80 — Values in Lux, Scale 1:21

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	184	164	196	0.893
Floor	20	184	164	198	0.895
Ceiling	70	548	203	7051	0.371
Walls (4)	50	307	75	1270	/

Workplane:
Height: 0.000 m
Grid: 16 x 8 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 1.680, Ceiling / Working Plane: 2.984.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	Crompton. 01 CCS-100-40-65-SL-DP-NWH (1.000)	4000	4000	40.0
			Total: 8001	Total: 8000	80.0

Specific connected load: 19.70 W/m² = 10.73 W/m²/100 lx (Ground area: 4.06 m²)

6.10:DESIGN SUMMARY AND BILL OF MATERIALS OF GROUND FLOOR DESIGN:

SL. No	Room name	Average Illumination level (lx)	Type and Wattage of Luminaire (W)	Quantity	Floor area (m2)	LPD (W/m2)
1	TOILET FEMALE 1	94	LED 18-Watt Round surfaced Downlighter & LED 12-Watt Round surfaced Downlighter	4&5	33.81	3.69
2	JANITOR ROOM	53	LED 18-Watt Round surfaced Downlighter	1	2.32	7.25
3	DA TOILET	99	LED 18-Watt Round surfaced Downlighter	2	3.60	9.33
4	TOILET MALE 1	113	LED 18-Watt Round surfaced Downlighter & LED 12-Watt Round surfaced Downlighter	8&3	45.57	3.71
5	WAITING LOBBY	3.71	LED 18-Watt Round surfaced Downlighter	37	165.24	3.76
6	TICKET COUNTER	191	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	12.96	5.76
7	ELECTRICAL ROOM	184	LED 40-Watt batten Downlighter	2	19.70	4.06

8	BACKSTAGE	104	LED 18-Watt Round surfaced Downlighter	7	49.64	2.37
9	CORRIDOR 1	164	LED 18-Watt Round surfaced Downlighter	24	112.78	3.58
10	CORRIDOR 2	175	LED 18-Watt Round surfaced Downlighter	20	90.34	3.72
11	GREEN ROOM 1	178	LED 18-Watt Round surfaced Downlighter	6	21.63	4.66
12	TOILET_ GREEN ROOM 1	121	LED 18-Watt Round surfaced Downlighter	2	4.20	8.00
13	GREEN ROOM 2	180	LED 18-Watt Round surfaced Downlighter	6	21.89	4.60
14	TOILET_ GREEN ROOM 2	117	LED 18-Watt Round surfaced Downlighter	2	4.83	6.96
15	STAIR	52	LED 18-Watt Round surfaced Downlighter	3	29.00	1.74
16	SEMINAR ROOM	357	LED 36-Watt square 2x2 ft tile surfaced Downlighter	24	162.36	5.51
17	WAREHOUSE	165	LED 36-Watt square 2x2 ft tile surfaced Downlighter	4	41.04	3.64
18	CORRIDOR 3	148	LED 18-Watt Round surfaced Downlighter	28	131.65	3.57
19	CORRIDOR 4	142	LED 18-Watt Round surfaced Downlighter	50	327.34	2.57

20	MV PANNEL ROOM	217	LED 36-Watt square 2x2 ft tile surfaced Downlighter	6	61.38	3.65
21	EXHIBITION SPACE	426	LED 36-Watt square 2x2 ft tile surfaced Downlighter and LED 36-Watt suspended linear Downlighter	21& 22	227.42	6.71
22	MULTIPURPU SE HALL	300	LED 36-Watt square 2x2 ft tile surfaced Downlighter	12	86.66	5.17
23	ELECTRICAL ROOM 2	130	LED 40-Watt batten Downlighter	2	11.77	5.24
24	MEMORIAL HALL	165	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	106.66	2.80
25	CORRIDOR 5	152	LED 18-Watt Round surfaced Downlighter	8	637.63	2.37
26	CORRIDOR 6	161	LED 18-Watt Round surfaced Downlighter	24	92.86	4.34
27	CORRIDOR 7	177	LED 18-Watt Round surfaced Downlighter	127	677.68	3.15
28	CAFETERIA	357	LED 36-Watt square 2x2 ft tile surfaced Downlighter	23	171.70	5.00
29	KITCHEN	285	LED 36-Watt square 2x2 ft tile surfaced Downlighter	4	31.01	4.81
30	TOILET F_CAFETERIA	137	LED 18-Watt Round surfaced Downlighter	4	9.91	6.78

31	TOILET M_CAFETERIA	124	LED 18-Watt Round surfaced Downlighter and LED 12-Watt Round surfaced Downlighter	3&2	14.57	5.04
32	SHOP 1	176	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	20.88	3.57
33	SHOP 2	176	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	20.89	3.57
34	SHOP 3	176	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	20.88	3.57
35	SHOP 4	180	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	19.71	3.78

6.11: FIRST FLOOR SIMULATION DESIGN DETAILS

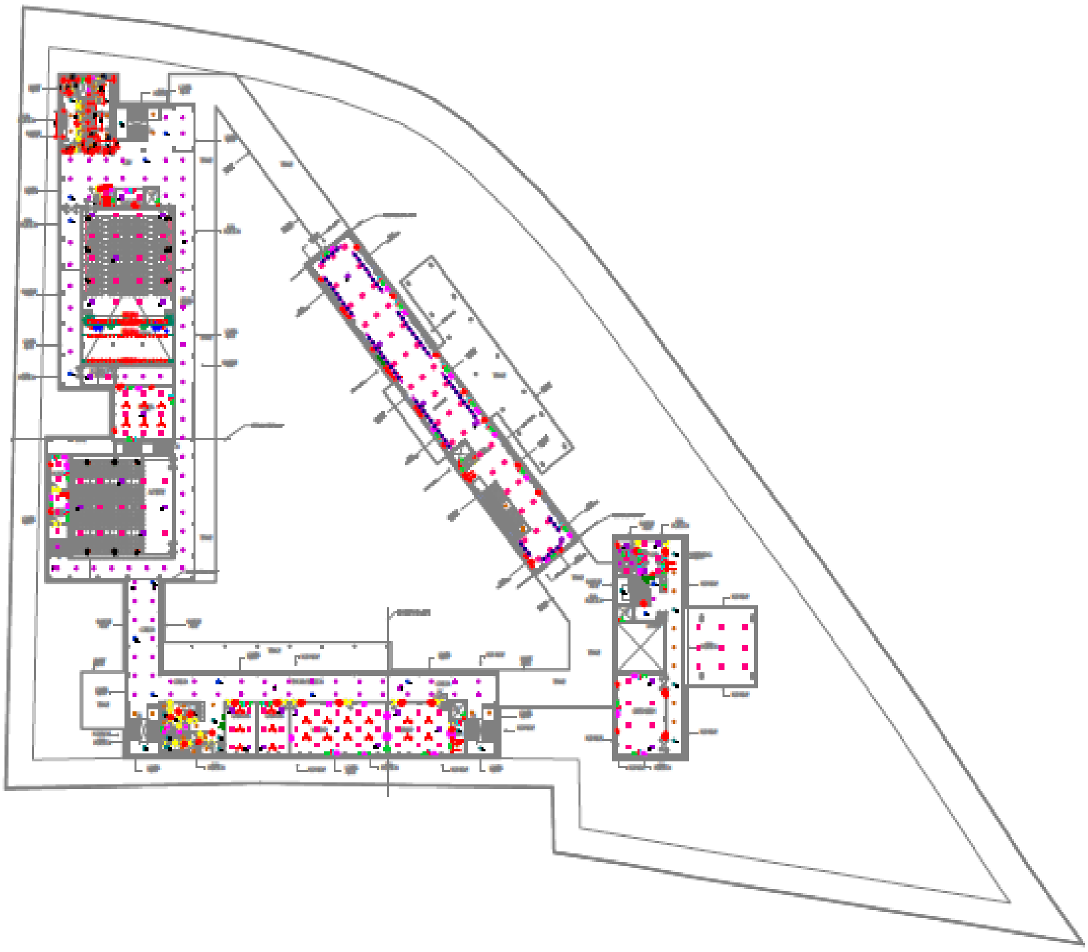


Fig.6.11.1: Layout of First Floor Plan of Convention Center

6.12.THE DESIGN CONSIDERATIONS ARE:

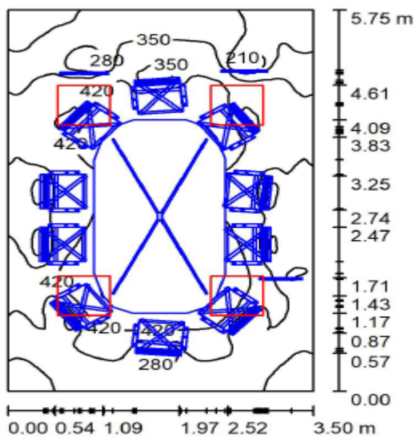
First floor of the convention canter comprised of varied rooms with individual applications and its individual illumination requirements. So, illumination level and other criteria of all those individual rooms are to be met.

- The design must be glare free and friendly for the occupants.
- Reflectance factor of Ceiling, Wall and Floor are considered as 70%, 50% and 20% respectively as the indoor facility is quite clean and less dust accumulation.
- Maintenance Factor (MF) is considered as 0.80 for LED application.

The complete design of the first floor is summarized in the design summary. The major areas in the ground floors are discussed below. DIALux 4.13 simulation results are as follows:

- **CONFERENCE ROOM:** This a room provided for singular events such as business conferences and meetings. Design summary is furnished below.

COFERENCE_ROOM / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 — Values in Lux, Scale 1:74

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	353	137	478	0.388
Floor	20	157	40	275	0.253
Ceiling	70	108	70	132	0.649
Walls (4)	50	221	90	516	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.702, Ceiling / Working Plane: 0.307.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 14959	Total: 15134	149.2

Specific connected load: 7.41 W/m² = 2.10 W/m²/100 lx (Ground area: 20.13 m²)

Fig.6.12.1: 3D Modelling of Conference Room

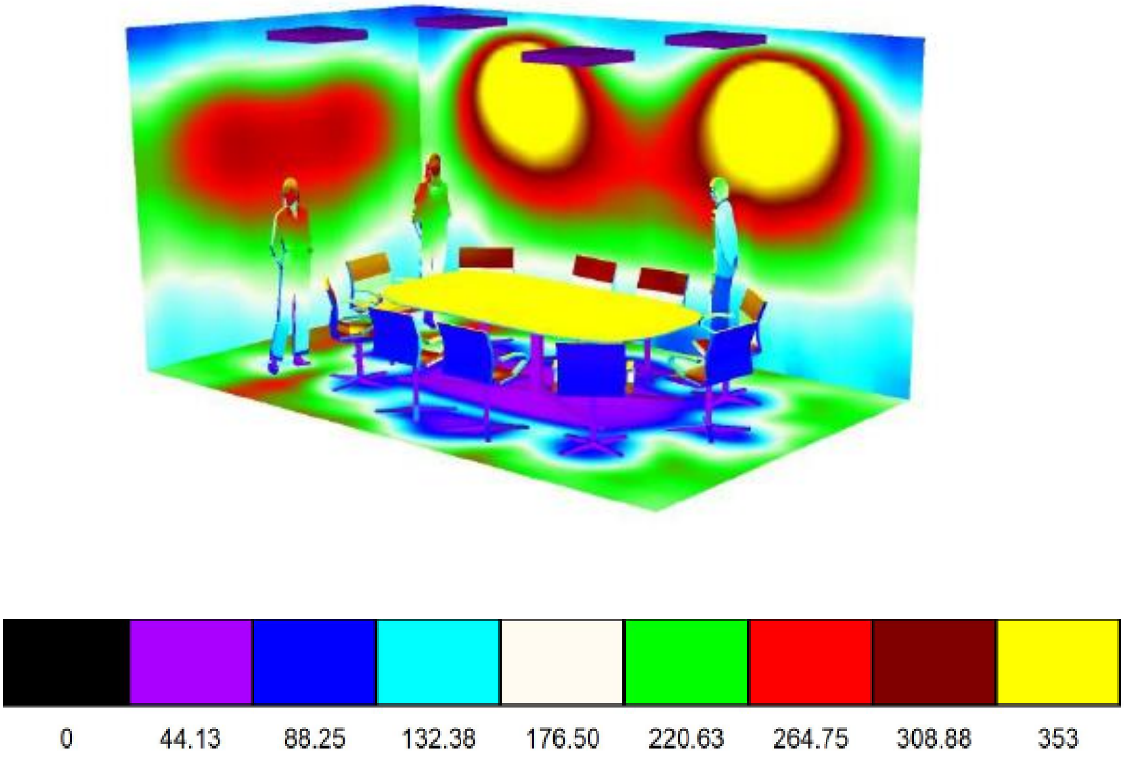
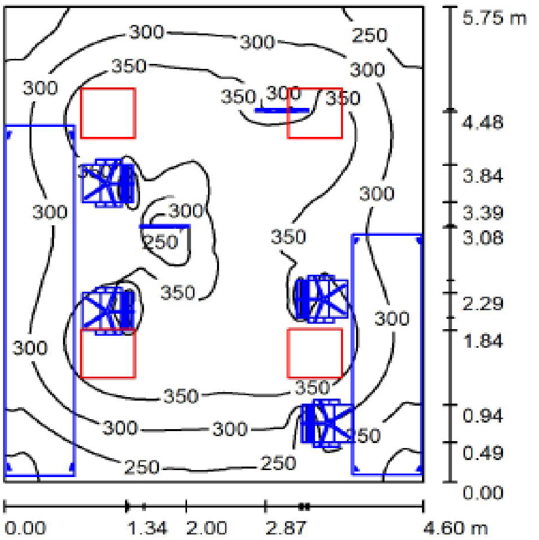


Fig.6.12.2: False Colour Rendering of Conference Room

➢ **ADMIN OFFICE**: A place used primarily for day-to-day activities that are related to administrative tasks such as financial planning, record keeping & billing, personnel, physical distribution and logistics, within a business. Design summary is furnished below.

ADMIN_OFFICE / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:74

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	317	185	402	0.584
Floor	20	208	33	319	0.157
Ceiling	70	76	53	107	0.691
Walls (4)	50	168	31	321	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.597, Ceiling / Working Plane: 0.240.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 14959	Total: 15134	149.2

Specific connected load: 5.64 W/m² = 1.78 W/m²/100 lx (Ground area: 26.45 m²)

Fig.6.12.3:3D Modelling of Admin Office

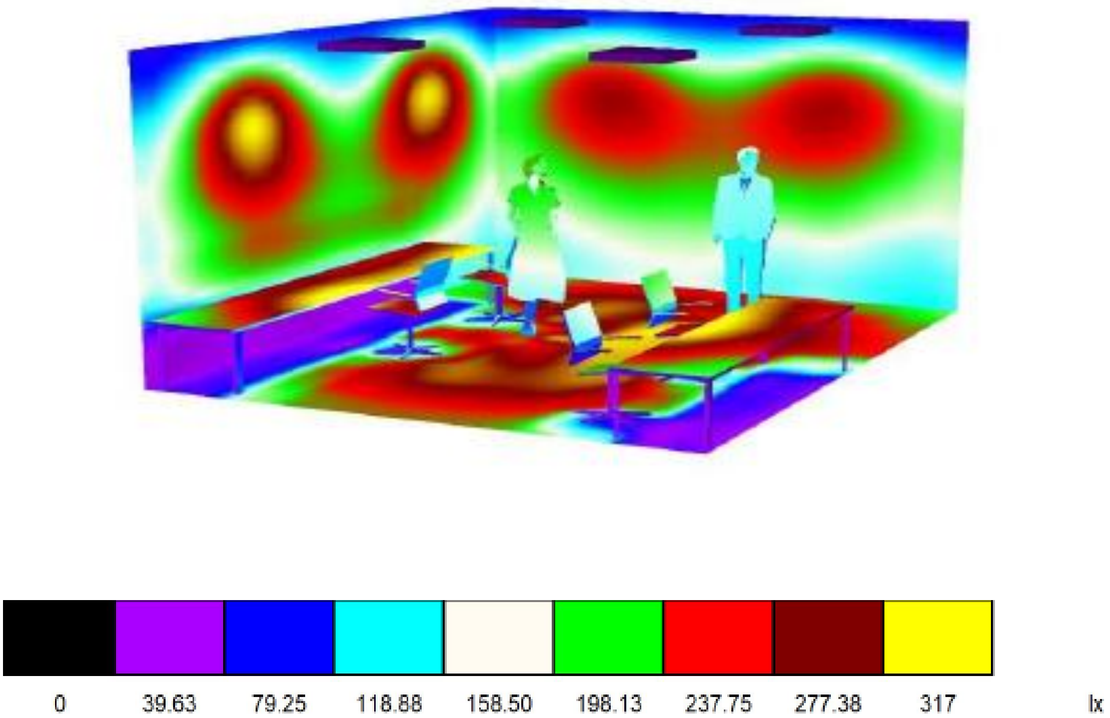
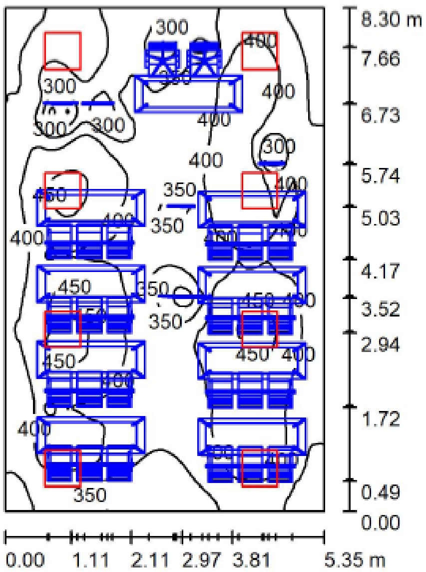


Fig.6.12.4: False Colour Rendering of Admin Office

➢ **LECTURE HALL:** A lecture hall (or lecture theatre) is a large room used for instruction. Lecture halls are excellent for focusing the attention of a large group on a single point, either an instructor or an audio-visual presentation. The modern lecture halls often feature audio-visual equipment. Design summary is furnished below.

LECTURE HALL 1 / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:107

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	384	230	467	0.600
Floor	20	197	50	334	0.253
Ceiling	70	109	50	138	0.462
Walls (4)	50	244	95	716	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.723, Ceiling / Working Plane: 0.283.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	8	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
		Total:	29919	Total: 30267	298.4

Specific connected load: 6.72 W/m² = 1.75 W/m²/100 lx (Ground area: 44.40 m²)

Fig.6.12.5: 3D Modelling of Lecture Hall

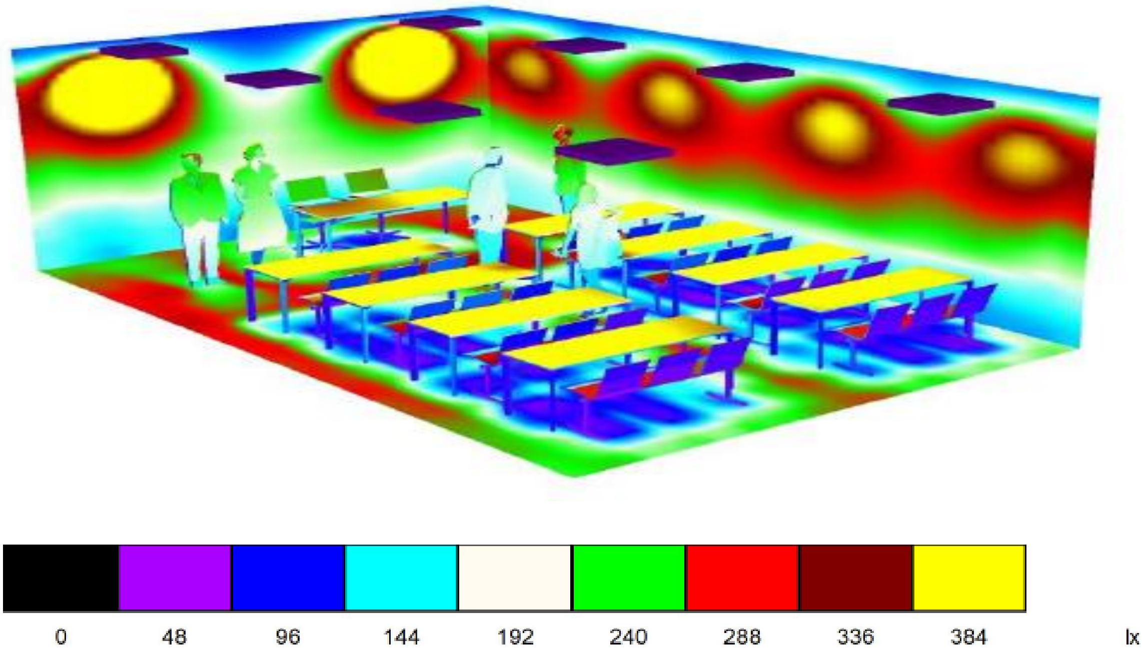
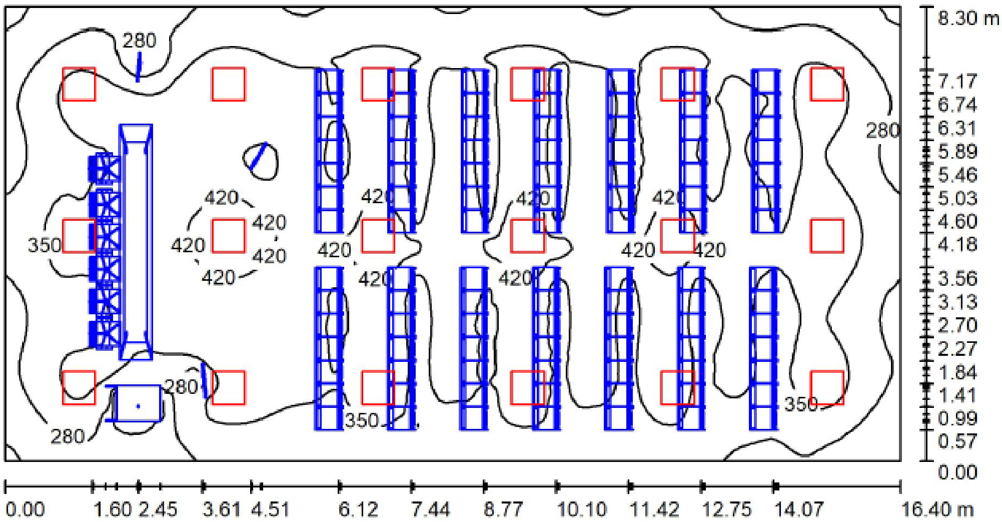


Fig.6.12.6: False Colour Rendering of Lecture Hall

- **WORKSHOP**: Workshops typically comprises of a general session together with face-to-face groups of participants training together to gain new knowledge, skills, or insights into problems. Design summary is furnished below.

WORKSHOP 1 / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:118

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	349	156	460	0.447
Floor	20	249	34	383	0.139
Ceiling	70	79	63	116	0.796
Walls (4)	50	185	73	277	/

Workplane:

Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.546, Ceiling / Working Plane: 0.227.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	18	Crompton Greaves Consumer Electricals Ltd 1 LCTLSNE-36-FO-CDL (1.000)	3740	3783	37.3
			Total: 67317	Total: 68101	671.4

Specific connected load: 4.93 W/m² = 1.41 W/m²/100 lx (Ground area: 136.12 m²)

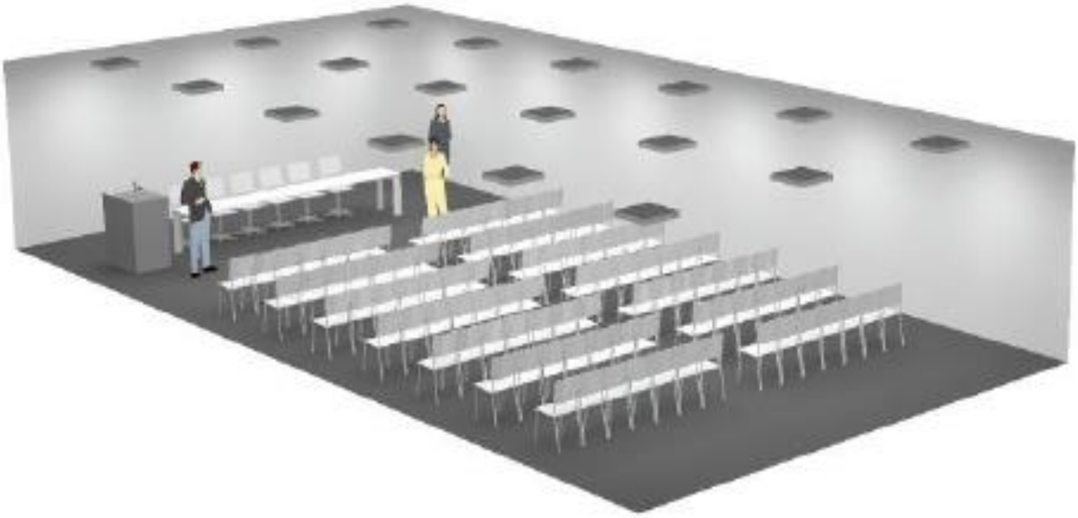


Fig.6.12.7:3D Modelling of Workshop

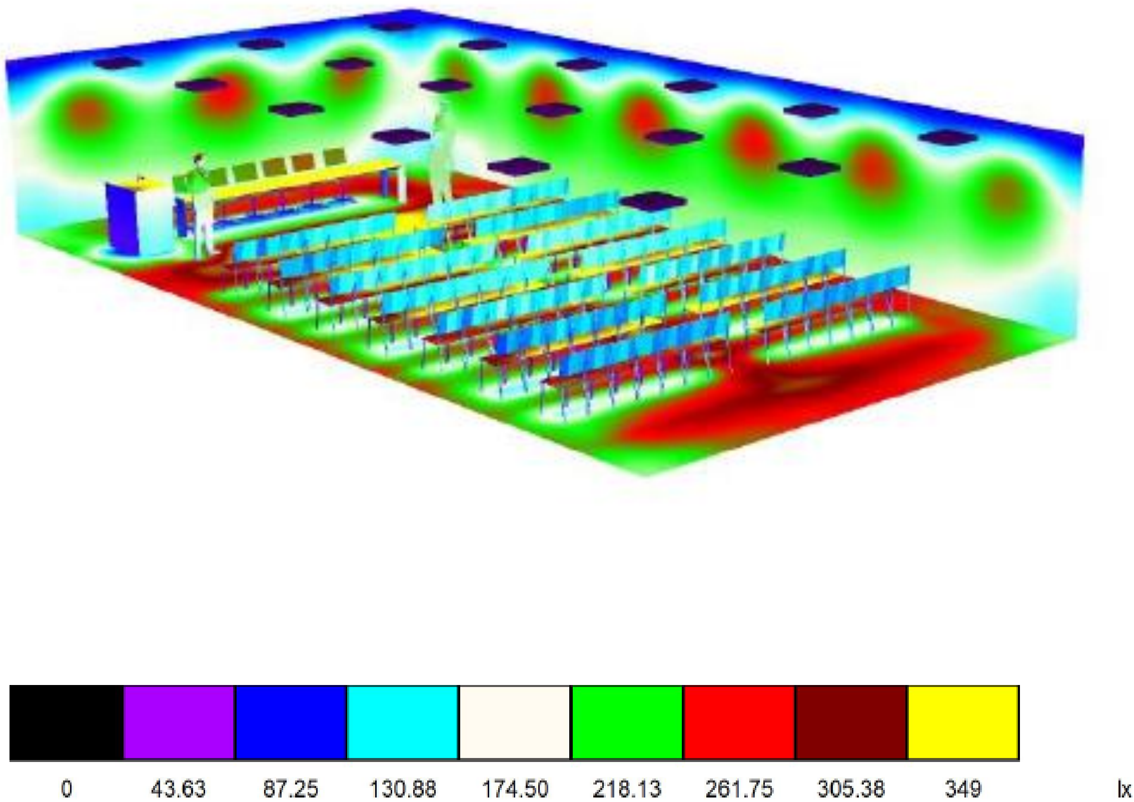
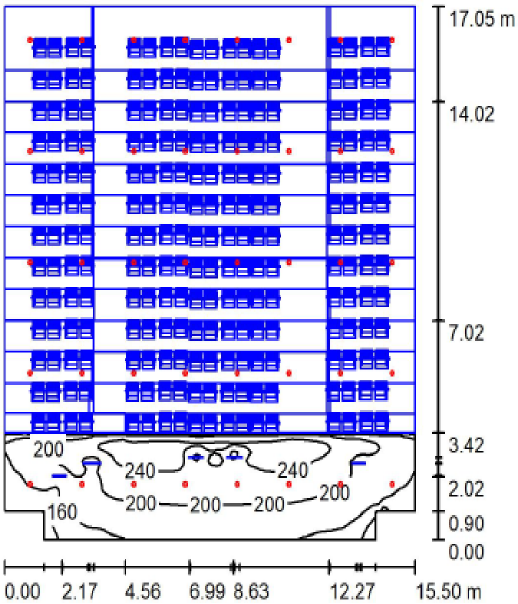


Fig.6.12.8: False Colour Rendering of Workshop

➢ **CONFERENCE HALL**: Theatre style conference hall used for product launch presentation displays used to present number of delegates. Design summary is furnished below.

CONFERENCE HALL 1 / Summary



Height of Room: 7.500 m, Mounting Height: 7.500 m, Light loss factor: 0.80 Values in Lux, Scale 1:219

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	196	86	262	0.438
Floor	20	43	2.42	253	0.056
Ceiling	70	67	37	667	0.558
Walls (8)	50	74	7.01	234	/

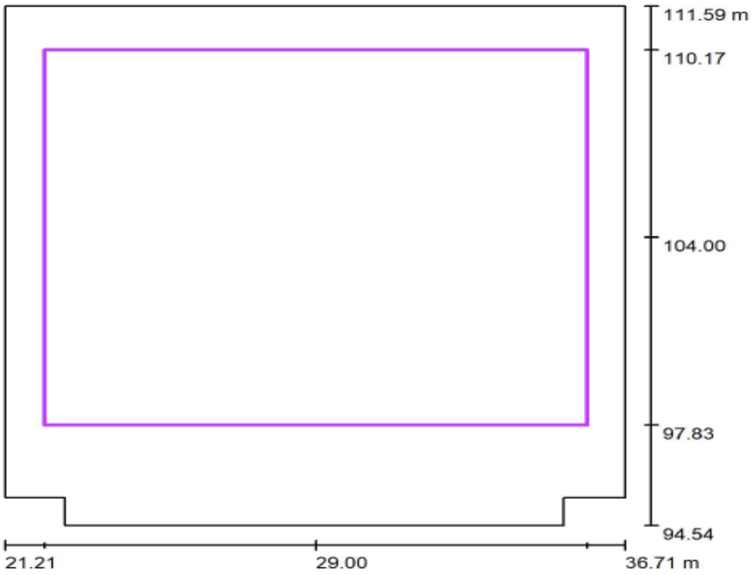
Workplane:
Height: 0.000 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.374, Ceiling / Working Plane: 0.341.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	40	Crompton Greaves Consumer Electricals Ltd 01 CDR-213-24-40-SL-NWH (1.000)	2570	2721	25.0
			Total: 102817	Total: 108844	1000.0

Specific connected load: 3.82 W/m² = 1.95 W/m²/100 lx (Ground area: 261.57 m²)

CONFERENCE HALL 1 / Calculation Grid @ SEATING AREA / Summary



Scale 1 : 163

Position: (28.997 m, 104.000 m, 2.700 m)
Size: (13.605 m, 12.966 m)
Rotation: (18.0°, 0.0°, 0.0°)
Type: Normal, Grid: 7 x 7 Points

Results overview

No.	Type	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}	$E_{h\,m}/E_m$	H [m]	Camera
1	perpendicular	312	200	386	0.64	0.52	/	0.000	/

$E_{h\,m}/E_m$ = Relationship between middle horizontal and vertical illuminance, H = Measuring Height

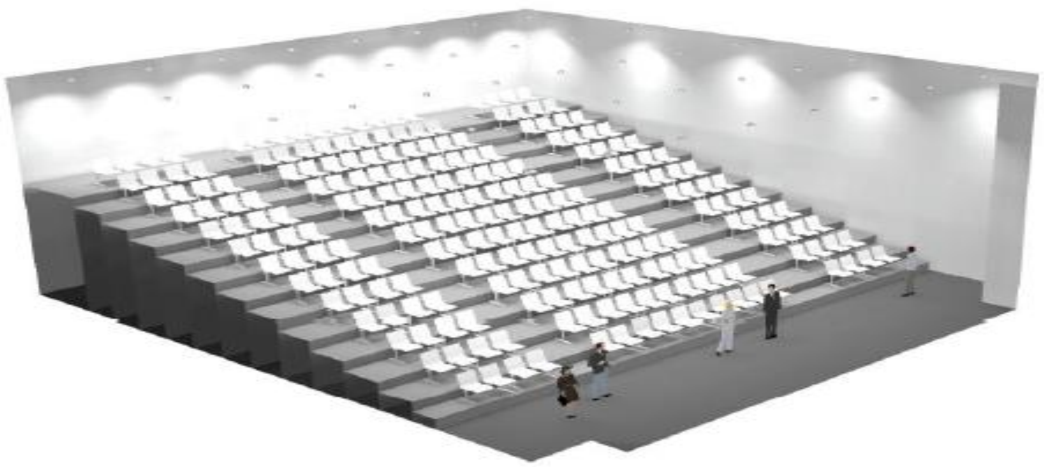


Fig.6.12.9:3D Modelling of Conference Hall

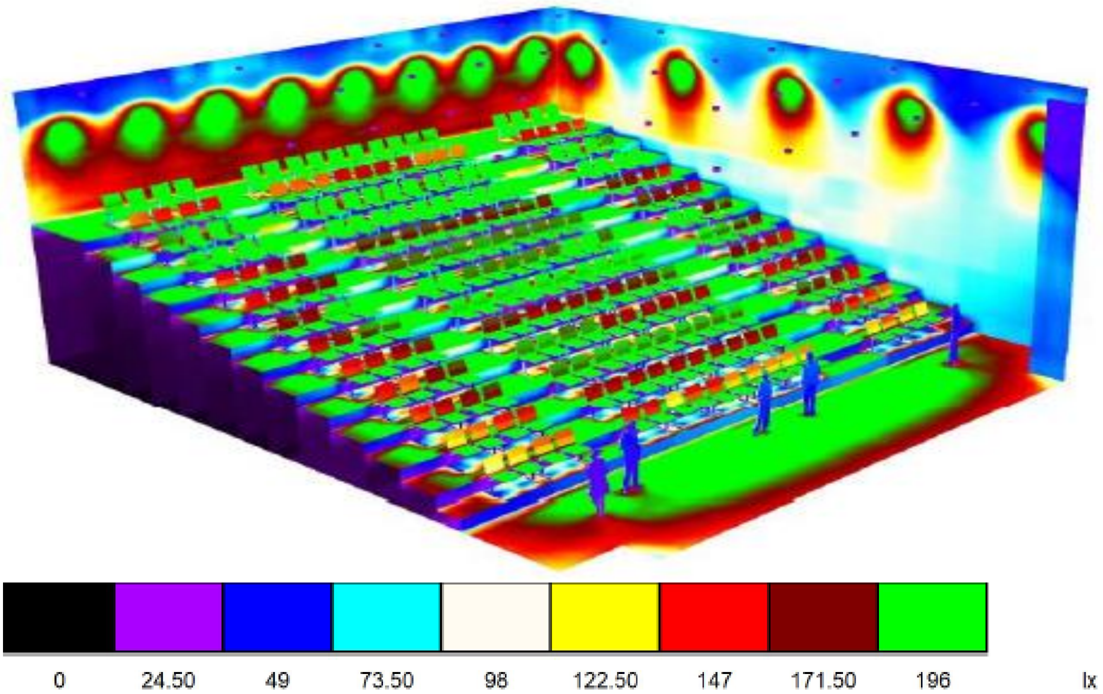
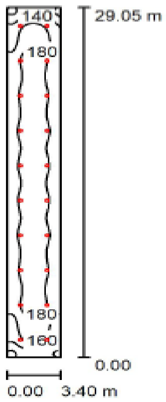


Fig.6.12.10: False Colour Rendering of Conference Hall

- **CORRIDOR :** A long passage in a building from which doors lead into rooms. Design summary is furnished below.

CORRIDOR 1 / Summary



Height of Room: 3.000 m, Mounting Height: 3.000 m, Light loss factor: 0.80 — Values in Lux, Scale 1:374

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	173	113	197	0.656
Floor	20	173	113	198	0.653
Ceiling	70	58	42	1332	0.717
Walls (4)	50	123	53	255	/

Workplane:
Height: 0.000 m
Grid: 32 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.713, Ceiling / Working Plane: 0.347.

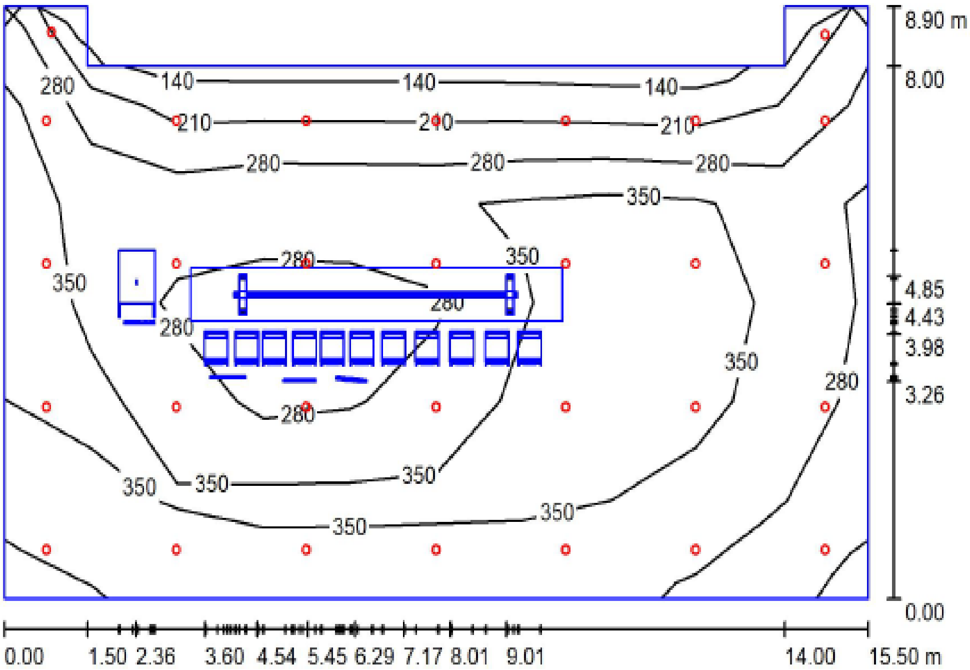
Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	20	Crompton Greaves Consumer Electricals Ltd 01 LCDSPLN-R-18-CDL (1.000)	1716	1715	16.8
			Total: 34316	Total: 34304	336.0

Specific connected load: 3.40 W/m² = 1.97 W/m²/100 lx (Ground area: 98.70 m²)

- **STAGE:** Stage is defined as to arrange, present or exhibit something that also combines music, spoken dialogue, and dance. Design summary is furnished below.

CONFERENCE HALL_STAGE / Summary



Height of Room: 7.000 m, Mounting Height: 7.000 m, Light loss factor: 0.80 Values in Lux, Scale 1:115

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	330	104	415	0.315
Floor	20	3.71	0.95	10	0.256
Ceiling	70	91	64	686	0.707
Walls (8)	50	144	18	1423	/

Workplane:

Height: 0.500 m
Grid: 6 x 10 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.467, Ceiling / Working Plane: 0.278.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	30	Crompton Greaves Consumer Electricals Ltd 01 CDR-213-24-40-SL-NWH (1.000)	2570	2721	25.0
			Total: 77113	Total: 81633	750.0

Specific connected load: 5.92 W/m² = 1.79 W/m²/100 lx (Ground area: 126.70 m²)

Fig.6.12.11:3D Modelling of Stage

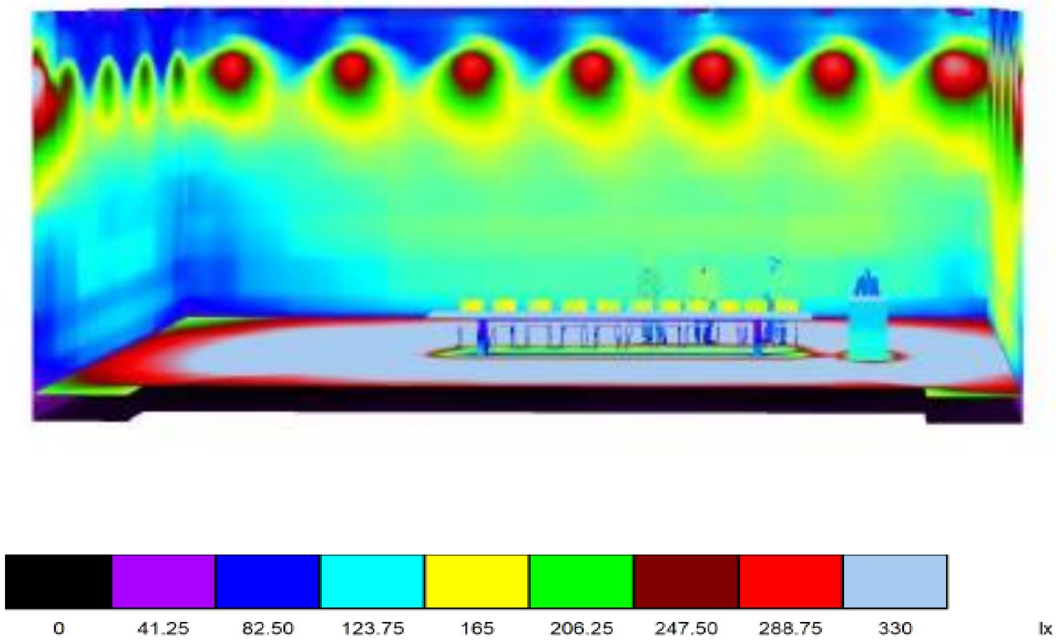


Fig.6.12.12: False Colour Rendering of Stage

6.13:DESIGN SUMMARY AND BILL OF MATERIALS OF FIRST FLOOR DESIGN:

SL. No	Room name	Average Illumination level (lx)	Type and Wattage of Luminaire (W)	Quantity	Floor area (m2)	LPD (W/m2)
1	BABY CARE	139	LED 18-Watt Round surfaced Downlighter	2	5.10	6.59
2	TOILET FEMALE 1	110	LED 18-Watt Round surfaced Downlighter & LED 12-Watt Round surfaced Downlighter	4&5	33.81	3.69
3	JANITOR ROOM	87	LED 18-Watt Round surfaced Downlighter	1	2.32	7.25
4	DA TOI	115	LED 18-Watt Round surfaced Downlighter	2	3.60	6.39
5	TOI M 1	113	LED 18-Watt Round surfaced Downlighter & LED 12-Watt Round surfaced Downlighter	8&3	45.57	3.71
6	LOBBY	193	LED 18-Watt Round surfaced Downlighter	39	220.18	2.98
7	SOUND CONTROL ROOM	260	LED 36-Watt square 2x2 ft tile surfaced Downlighter	2	12.85	5.80
8	ELECTRICAL ROOM	184	LED 40-Watt batten Downlighter	2	5.33	4.06

9	CORRIDOR 1	173	LED 18-Watt Round surfaced Downlighter	20	98.70	3.40
10	CORRIDOR 2	160	LED 18-Watt Round surfaced Downlighter	24	118.59	3.40
11	CONFERENCE HALL 1	196	LED 24-Watt spot light	40	261.57	3.82
12	CONFERENCE HALL 1 _STAGE	330	LED 24-Watt spot light	30	126.70	5.92
13	AUDI SERVICE ACCESS	226	LED 36-Watt square 2x2 ft tile	2	17.05	4.38
14	SERVICE ROOM	175	LED 18-Watt Round surfaced Downlighter	6	30.38	3.32
15	REHEARSAL ROOM	247	LED 36-Watt square 2x2 ft tile	9	87.33	3.84
16	AV ROOM	166	LED 36-Watt square 2x2 ft tile recessed Downlighter	20	290.28	2.36
17	CORRIDOR 2	131	LED 18-Watt Round surfaced Downlighter	23	152.16	2.54
18	SOUND /PROJECTOR ROOM	287	LED 36-Watt square 2x2 ft tile	2	16.12	4.63
19	CORRIDOR 3	144	LED 18-Watt Round surfaced Downlighter	50	344.32	2.44
20	LECTURE HALL 1	384	LED 36-Watt square 2x2 ft tile surfaced Downlighter	8	44.40	6.72
21	LECTURE HALL 2	384	LED 36-Watt square 2x2 ft tile surfaced Downlighter	8	44.40	6.72

22	WORKSHOP 1	349	LED 36-Watt square 2x2 ft tile surfaced Downlighter	18	136.12	4.13
23	WORKSHOP 2	349	LED 36-Watt square 2x2 ft tile surfaced Downlighter	18	136.12	4.13
24	CRAFT MUSEUM	203	LED 36-Watt square 2x2 ft tile surfaced Downlighter	8	106.65	2.80
25	ENTRANCE PORCH	115	LED 36-Watt square 2x2 ft tile surfaced Downlighter	9	150.75	2.23
26	COFERENC E_ROOM	364	LED 36-Watt square 2x2 ft tile surfaced Downlighter	4	20.13	7.41
27	ART GALLARY	430	LED 36-Watt square 2x2 ft tile surfaced Downlighter and LED 36-Watt suspended linear Downlighter	44&37	454.74	6.36
28	ADMIN_OF FICE	317	LED 36-Watt square 2x2 ft tile surfaced Downlighter	4	26.45	5.64

CHAPTER - 7: RESULTS AND ANALYSIS

7.1: INTRODUCTION:

In the previous chapter of the case studies, some important design areas are showcased to indicate the design methodology and luminaires specifications used for convention center applications. It should be taken care at the time of designing that not only should the designs fulfil the requirements defined by the client, but they should also be feasible in terms of the LPD values.

The features of lighting that are observable by building occupants are illumination level (lux), uniformity, layout, and aesthetic considerations such as colour rendition, etc. These design-related aspects of lighting are generally beyond the scope of most energy auditors. Lighting power density is a simple screening measure that indicates whether a space offers opportunities for energy savings. Lighting Power Density (LPD) is defined as watts of lighting per square foot of room floor area or as watts of lighting per square meter (W/m^2) of room floor area.

7.2: ANALYSIS OF CASE STUDIES:

In this section, analysis of the case study designs is illustrated, discussed in the Chapter-6 on the basis of energy conservation parameters as per the codes and guidelines provide in the Chapter-5.

7.2.1: ILLUMINATION DESIGN OF CONVENTION CENTER (SEMINAR TYPE):

Table 7.2.1.1: Floor area and total power consumption of convention center seminar type

Case Study Design	Total Floor Area (m^2)	Total Power Consumption (Watt)
Convention center seminar type	632.92	3120

By calculation, the LPD of the convention center (seminar type)

$$LPD = \left(\frac{3210}{632.92}\right) W/m^2$$

$$LPD = 5 W/m^2$$

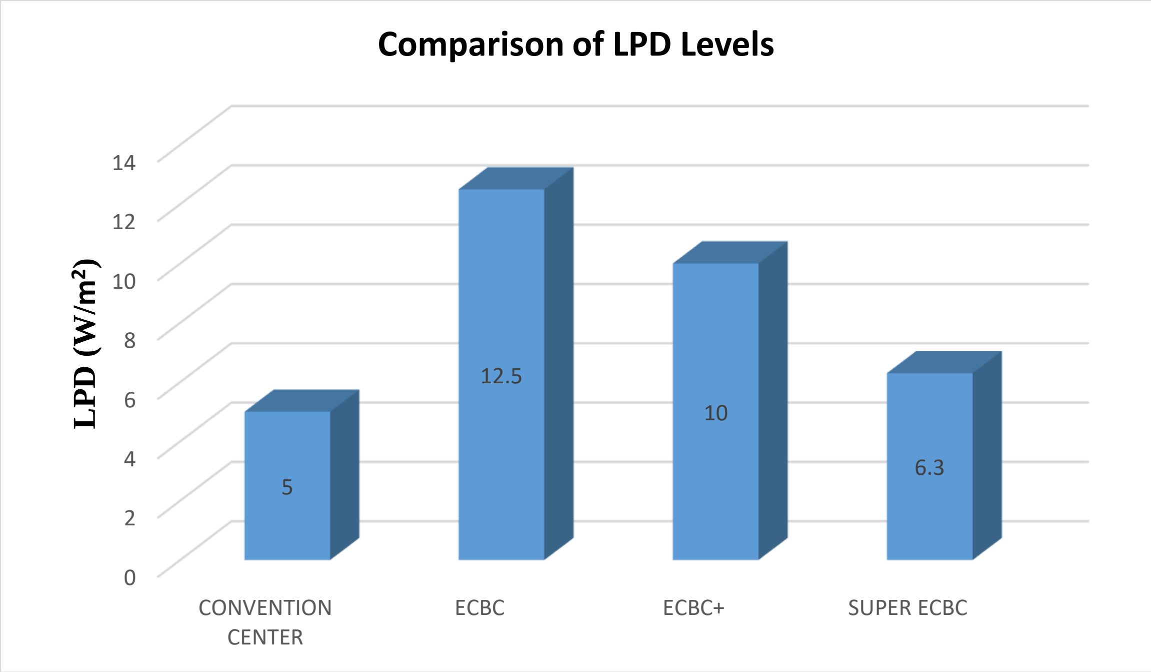


Fig 7.2.1.1: LPD level comparisons between ECBC, ECBC+ and Super ECBC - Building Area Method convention center standards and Case study design

The interior lighting power standards furnished by ECBC, ECBC+ and Super ECBC – Building Area Method are 12.5 W/m^2, 10 W/m^2& 6.3 W/m^2 respectively for convention center. The LPD of the design, that is, 5W/m^2 which is much lesser than all other limits. Hence, it can be stated that design is Energy Efficient Design.

7.2.2. CONVENTION CENTER ILLUMINATION DESIGN (ALL PURPOSE TYPE):

Table 7.2.2.1: Floor area and total power consumption ofconvention center all-purpose type

Case Study Design	Total Floor Area (m^2)	Total Power Consumption (Watt)
Convention center	6329.52	23430

By calculation, the LPD of the convention center

$$LPD = \left(\frac{23430}{6329.52}\right) W/m^2$$

$$LPD = 3.7\ W/m^2$$

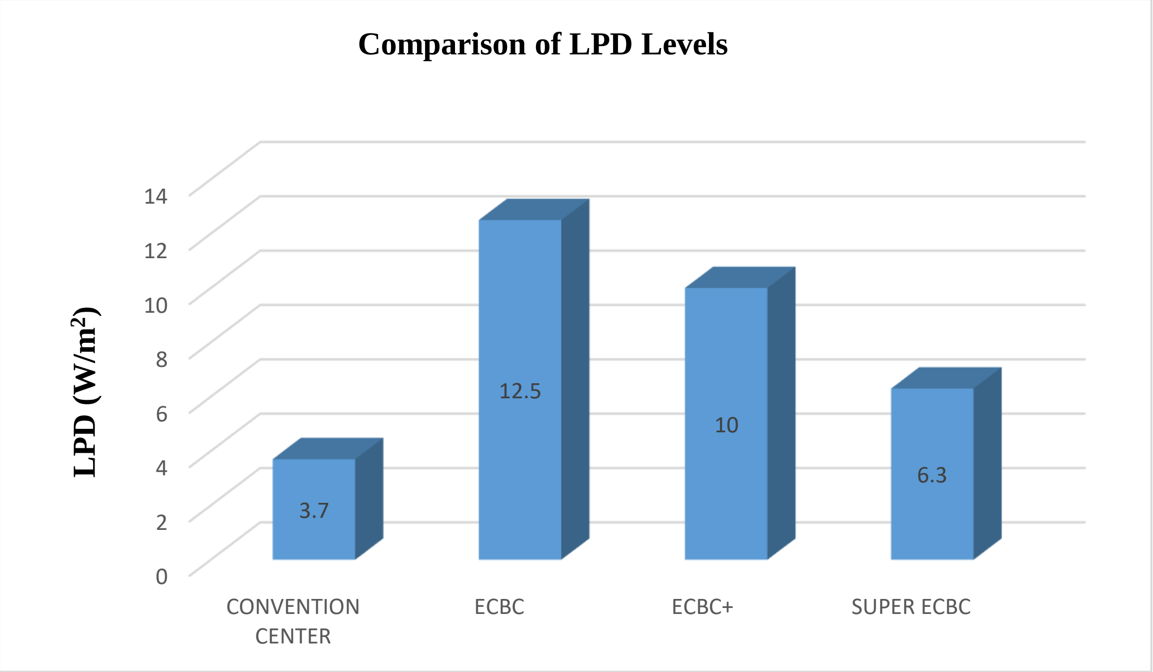


Fig7.2.2.1: LPD level comparisons between ECBC, ECBC+ & Super ECBC - Building Area Method convention center standards and Case study design

The interior lighting power standards furnished by ECBC, ECBC+ and Super ECBC – Building Area Method are 12.5 W/m^2, 10 W/m^2& 6.3 W/m^2 respectively for convention center. The LPD of the design, that is, 3.7 W/m^2 which is much lesser than all other limits. Hence, it can be stated that design is Energy Efficient Design.

CHAPTER-8: SUMMARY AND CONCLUSION AND FUTURE SCOPE

8.1: SUMMARY:

This project deals with analysing the process and activities in various areas of a convention center, and provides an optimal illumination design for aesthetic and energy efficient lighting solution in adherence to all relevant lighting standards, which will also lead to efficient energy savings. Illumination designs in all areas were done using LED luminaires. A comparison of different lighting installation schemes in various areas of the convention center building was drawn in terms of light power density, average illuminance etc. From the comparison, appropriate energy efficient lighting solutions were recommended area wise. In designing the convention centre and allied areas efforts have been made so that Glare value remain within the stipulated limit and avoid direct beam from the sources. The CCT values of luminaries has been taken considering the application of the room. As the area has exhibition centre where it is important to highlight the trueness of the object more appropriately hence the lamps as well as luminaires have been chosen in accordance to the CRI value so that true colour can be evolved and also choosing the right beam angle is to get the best uniformity, proper highlight, etc. Effort has also been made to install the optimum number of luminaires. The ultimate motivation in design has been made considering techno-commercial and attractive design for people maintaining all recommended standards and codes. During the practical implementation of these designs however minor changes may needed due to practical constraints at site which may occur during installation. Considering the possibility of such slight variations, in several instances, the measured values have been maintained at a higher level compared to the required level considering maintenance, lamp/luminaire aging, depreciation, ambient weather variations, etc.

8.2: CONCLUSION:

This project is focused on the Interior Lighting Design of a convention center, the main objectives of which were to propose energy efficient, aesthetic, glare free design, choosing the right beam angle and modern interior lighting design with help of modern and energy efficient lamps and luminaires. The design has been done for convention center area along with its allied areas such as meeting and conference room, exhibition space etc. As different activities take place in a convention center, proper care must be taken in lighting designing so that the purpose is fulfilled in an efficient manner. Appropriate illuminance value is very important so that the comfort level can be achieved for the viewer. LED lights have been preferred as a lighting solution for illuminating these spaces. LED light is advantageous in terms of reduced power consumption, better burning hours and minimum maintenance cost involvement. The design exercise included consultation of various relevant codes and guidelines as redesigning depended on aesthetic, energy-efficiency, accurate CRI value, CCT value, technical requirements and economy in compliance with relevant codes.

In addition to natural Sun-light, artificial light was required to supplement the inadequacy. The requirement for artificial lighting is reduced by efficient utilization of sunlight wherever possible. While making decisions regarding lighting design economic factors (initial costs, energy consumption, and maintenance) has also been taken into consideration. Thus, the design work has been made considering proper aesthetic taste, space utilization, daylight utilization, energy efficiency, etc.

8.3: FUTURE SCOPE:

The demand on energy resources is continually increasing over the years. There is a huge gap between the energy supply and demand. Energy efficiency along with renewable and non-conventional energy sources is required to ensure sustainable energy consumption in this world. Energy demand can be met by implementing different policies and methods for efficient energy consumption. Energy efficiency is the use of improved technology that need low energy to perform satisfactorily. It can be any process, technique or equipment that helps to achieve reduction in energy consumption while performing an operation and achieving the same or better level of output.

In designing of convention center building efforts have been made to make it energy efficient and eco-friendly. Daylight control by Artificial Intelligence and Machine Learning may be used so as to adjust average illuminance value in a particular area in such a manner that natural sunlight can be used effectively, Solar connected Smart grid device with facilities to draw power at night time from conventional power supply source will help in avoiding usage of Battery.

Light integrated scheme with adaptive controls provides the desired illuminance at appropriate times while maximizing the visual comfort, reducing the discomfort glare and energy use. All the daylight integrated systems make use of the light distribution from the sun. The availability of daylight is determined by the seasonal variation in the climatic conditions. A daylighting design solution should address ambient temperature and the building's facade also. Daylight – Artificial light integrated scheme has received significant attention in recent times. With the advancement in technology, various devices of artificial lighting control schemes have been developed by researches to reduce energy consumption by optimum usage of luminaires in the presence of daylight.

In other way use of Sunlight in buildings through windows, skylights, or light shelves will reduce considerable amount of total energy consumption from power source. It can be used as the main source of light during daytime in buildings. This can save energy by avoiding the use of artificial lighting. For providing daylight proper windows and shutters are provided. Window glass is provided as Tinted Heat-Absorbing Glass. It cuts down the sun's heat, enabling greater convenience and comfort inside the building. It also increases the aesthetic appearance of building. It also protects from glare and allows less visible light transmittance. Building orientation as well as building architecture to be judicially selected for maximum utilization of natural light sources.

For the purpose of auditorium lighting, theatre lighting there is minimum data is available in Indian Standard. Hence there is wide scope to work in this area so that better design can be achieved and those guidelines can be enumerated with the existing Indian Standard.

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