STUDIES ON SPORTS LIGHTING DESIGN AND ITS POWER SUPPLY SYSTEM FOR A FOOTBALL STADIUM

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in
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Submitted By,

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This is to certify that the thesis entitled **"Studies on sports lighting design and its power supply system for a Football Stadium",**is a bonafide work carried out by **Tanmoy Khan (M6ILT23014)** under on supervision and guidance for partial fulfilment of the requirement of M.Tech. (Illumination Technology and Design) in School of Illumination Science, Engineering and Design, during the academic session 2022 -2023.

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FINAL EXAMINATION FOR EVALUTION OF THESIS

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THESIS EXAMINER 1 THESIS EXAMINER 2

BOARD OF EXAMINERS

DECLARATION OF ORIGINALITY AND COMPLIANCE OF ACADEMIC ETHICS

I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as part of his M.Tech. (Illumination Technology and Design) studies during academic session 2022-2023..

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

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

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Chapter 1

Introduction

Football is one of the most popular and entertaining game due to its simple understandable rules, variety in style of play, suitability for play almost in any climatic condition and super fun. The role of television broadcasting of the matches conducted in the different part of the world can not be ignored behind the popularity of this sport.

Televised football match generally played after sunset to provide opportunity to lot of spectators to watch the match sitting in the stadium or home after the day's work. The match is played under artificial light.

As football is a multi direction aerial sport so appropriate quality of light is required for the performers, spectator, TV and media. The effective artificial light in a football stadium ensures an excellent lighting environment in the stadium and satisfy the need of players, spectators and TV media.

There is no universal method of designing lighting for different sports arena because of the variance in the size and shape of the sports facilities, different speed and size of the playing object, different standard of competition. So to design lightings for sports facility needs a detailed analysis of type of sports, standard of competition, size of field etc.

TV network and media requires an excellent lighting in the stadium to transmit good quality images. Though the requirement of light for televised and non-televised games is not same but the quality of light, i.e, illuminance uniformity, visual comfort should remain high.

Due to the advent of high power LED luminaires, the scenario of the sports field has changed drastically apart from providing quality light. These luminaires can produce an elegant visual ambiance in the stadium.

Chapter 2

Objective

The objective of designing lighting for a football stadium is to provide high quality light that will create good visibility conditions for –

- Players, referees, coaches and officials to perform their task efficiently.
- Each and every spectators in the stadium must see satisfactorily the performance of the players and surroundings.
- Media and TV film crew to obtain high quality images.

Besides these, the focus of the design is to minimize light pollution that may cause due to spill light, sky glow and high intensity light towards observer.

Chapter 3

Football — Background theory

3.1 A short description about Football game :

Football is a team game played with a ball between two teams having 11 players in each side. The objective of each team is to push the ball to other goal box by applying their skill and strategies. According to the law the players of defence, wing and forward positions can use their feet and other part of the body except their hands to roll the ball inside the field. Only goalkeeper is allowed to use hands to hold the ball within penalty box area around the box.
The match time is 90 minutes. The match is conducted in two halves. Duration of each half is 45 minutes.

3.2 FIFA — The governing body of Association Football :

Internationally, association football is governed by Federation of Internationale de Football Association (FIFA). This governing body founded with national football associations of Belgium, France, Netherlands, Spain, Denmark, Sweden and Switzerland in the year 1904.Under FIFA there are six regional confederation AFC, CAF, CONCACAF, CONMEBOL, OFC & UEFA. At present 211 national associations are the member of FIFA through any one of the above confederations.[13]

However, FIFA does not set the rules and regulations of the game. International football association board (IFAB) is responsible to frame the laws of the game. FIFA as a member of the said board implements the rules and regulation across all FIFA competitions.

National associations (like Indian Football Association) are responsible to look after professional or amature games in their own countries according to the law of the game.

3.3 Football ground and playing object :

The football ground is rectangular in shape and demarcated with lines. The surface of the pitch is even beyond its perimeter. The surface of the field may be natural or artificial and colour of it is green.

The lines drawn on the field represent the boundaries of the pitch. Two longer boundary lines are known as touch lines and other two shorter lines are known as goal lines.

The demarcated field is divided into two halves by drawing a line between midpoints of two touch lines. At the centre of this half way line a circle of 9.15m radius is drawn.[14] Match starts from this centre point and during kick off the players of opposition side are not allowed to stand inside the circle.

In the field there are two goal box in the middle of each side goal line. The rectangular goal box has a two posts and one cross bar. Distance between two posts is 7.32m and height of the lower edge of cross bar from the ground is 2.44m.

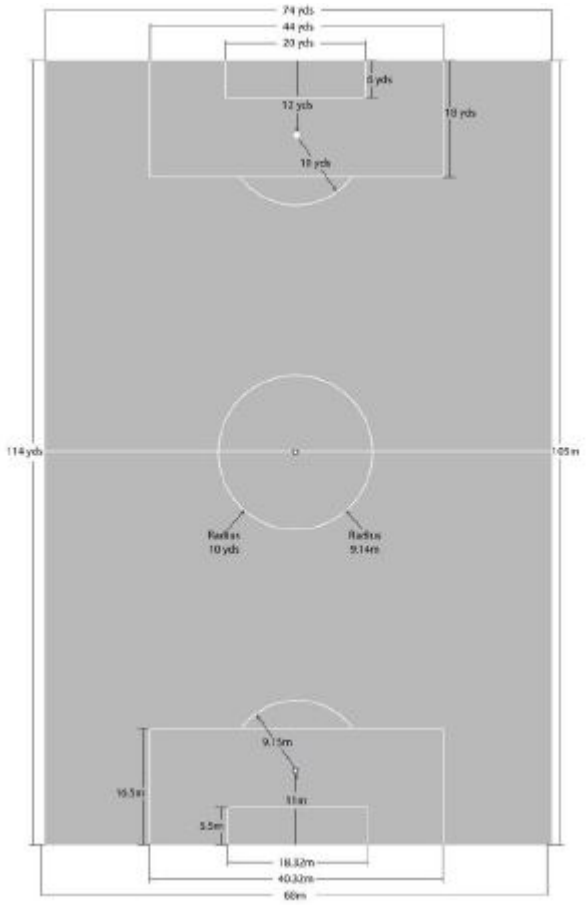


Figure 3.1: Outline of football field [1]

The size of the football pitch varies based on the number of players in the side. For five-a-side football match the length of the field would be 38 - 42m and width 18 - 22m. For seven-a-side match the length of the pitch will be 65 - 68m and width will be 45 - 90m. For eleven-a-side match, the length of the field will be 90-120m and width will be 45-90m.

The playing object, i.e, football is spherical in shape and made of leather or other suitable materials. Its circumference is 69 - 71cm and weight is 410 - 450gm.

Chapter 4

Stadium Lighting - A new era with LED luminaires

4.1 Conventional luminaires used in Sports facility

Prior to the development of high power LED luminaires suitable for outdoor sports facilities,high pressure sodium luminaire and metal halide luminaires were widely used. But use of those luminaires are restricted today due to introduction of cost effective, high efficient LED luminaires.

- The high pressure sodium lamps have high luminous efficacy, 150 lm/W but exhibit poor color rendering index (Ra = 25).[3]
  Therefore use of such lamp is confined to recreational outdoor sports only.
- Metal halide lamps have good lumious efficacy, 65 to 90 lm/W, high CCT value from 4000 to 6000K and very good color rendering index (Ra = 65 to 90). It can produce high quality light output too.
  But due to long switching time, high running and maintenance cost, short lifetime, these lumiaires are now being replaced by LED luminaires in many existing sports stadiums.

LED luminaires, have taken place of Metal halide luminaires in the outdoor sports facilities due to its following unique characteristics.

1. Highly energy efficient. Luminous efficacy range from 40 to 150 lm/W.
2. Long Service life (5 to 10 years) compared to Metal Halide lamps (1-2 years).
3. It has wide range of color temperature, 2200K to 6500K.
4. High CRI value from 65 to 95.
5. Produce directional light 0 - 180° as compared to Metal Halide lamp having 0 - 360° .
6. It takes no time to switch on as compared to Metal Halide lamps. M.H luminaire takes 5 to 10 minutes to give full power output.

4.2 LED sports luminaire

Light Emitting Diode (LED) is a semiconductor device that emits light when current flows through it. In the semiconductor recombination of electron and holes produce photons. The colour of the light depends on the energy of the photons. Usually in sports light white to cool white light of CCT 4000K to 6500K is used. This white light is obtained by using multiple semiconductors or a layer of light emitting phosphor on the semiconductor device. [17]

In LED lighting COB (chip on board) LED and SMD (Surface Mounted Device) technologies are used. But in sports light COB technology is used because it has a number of advantages over SMD technology.

- For the same array it can accommodate 8 to 9 times more LEDs than SMD technology.
- It can produce higher intensity and better uniform light.
- It consumes lesser energy than SMD.
- It emits only one colour that ensure more stable lighting which is required for stadium lighting.
- In SMD 3nos. primary colours, Red, Green & Blue are used. So colour temperature and colour of LED can be changed easily.

The optics (Reflector & Lens) used in these luminaires ensure narrow and medium narrow beam angle [16] which precisely focus light on the space where it needs and minimize spill of light.
For field lighting the beam spread angle is usually kept within a range of 20° - 30° .
The high power LED luminaires are run by constant current LED drivers. This driver vary the voltage along an electronic circuit and keep the current remain constant. In fact this driver and heat management system protect the LED luminaire from thermal-run-away.

Chapter 5

Pole mounting arrangement for football field

5.1 4 Pole corner/ side arrangement :

Generally a football stadium is associated with 4 masts or 6 masts or rim type lighting system or combination of mast & linear lighting systems.

The common football stadium lighting system is based on 4 masts lighting system. 4 masts can be mounted at the corner of the field in such a way that do not impede the normal viewing directions of the players with respect to goal lines and side lines.

4 masts can be positioned side wise behind the spectator stand. Arrangement of 4 corner mounted and side mounted masts on a football field are shown below.

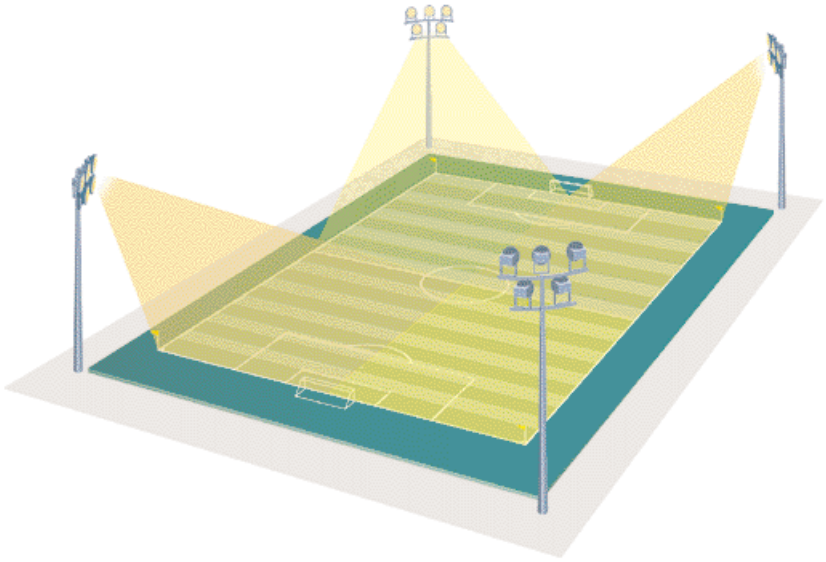


Figure 5.1: Arrangement of 4 corner pole [2]

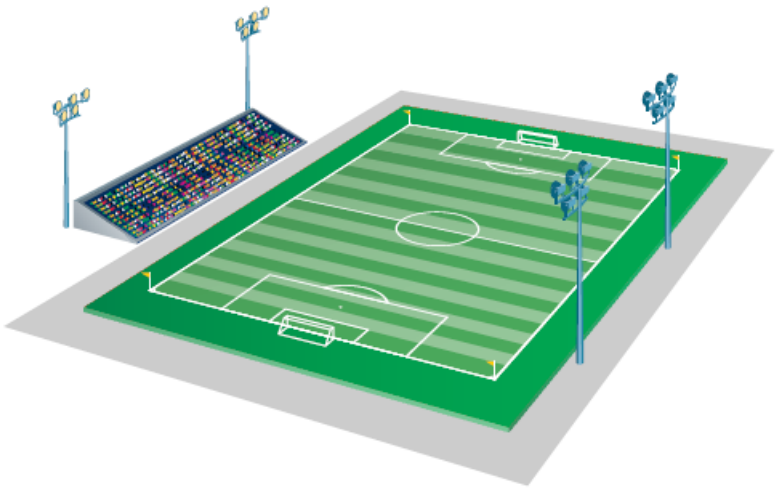


Figure 5.2: Arrangement of 4 side pole [2]

5.2 6 Pole arrangement :

The amount of spill light coming out from the 4 side pole arrangement can not be controlled efficiently like 6 or 8 pole arrangement.

The amount of average uniformity of illuminance on the field significantly increases compared to a 4 pole arrangement. More no. of poles soften the shadow of the players on the field.
6 poles mounting arrangement is shown in the figure below.

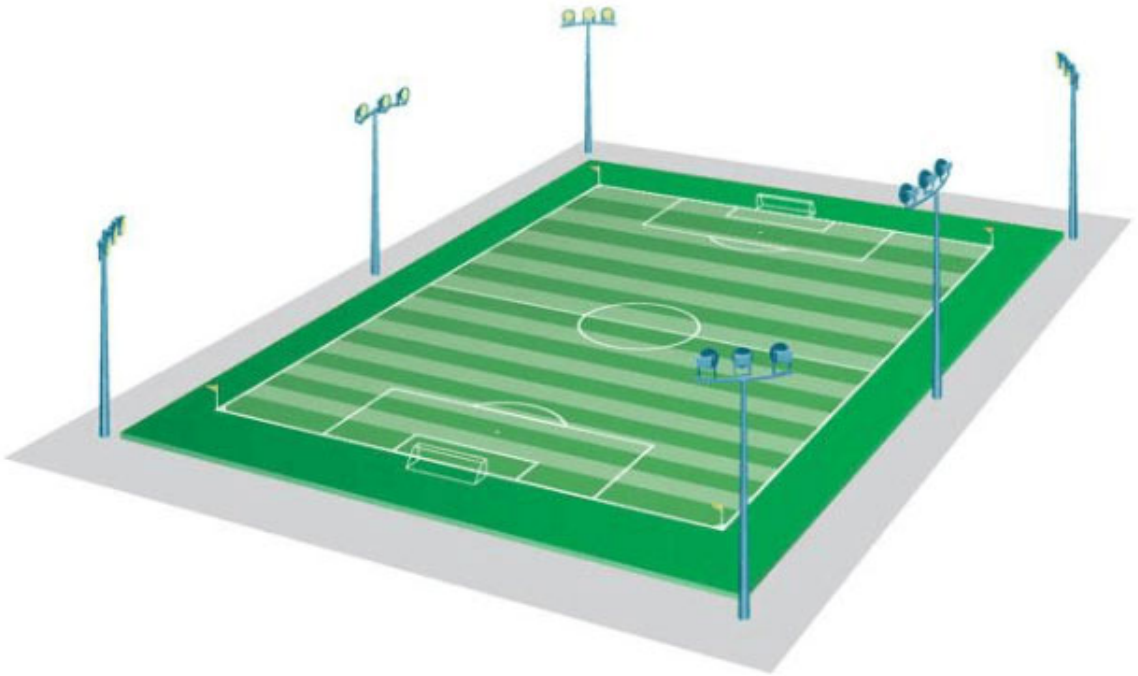


Figure 5.3: 6 pole arrangement

5.3 Comparative study between corner and side mounted arrangement of poles :

Corner Mounted	**Side Mounted**
1. Pole height is comparatively more than that of side mounted pole.	1. Pole height is lesser than the corner mounted pole.
2. Can produce dark patch in some spots on the field. Shadow of the player is observed on the field.	2. Soften the shadow of the player and greatly reduce the dark patch on the pitch.

Chapter 6

Design parameters and recommendation of National Lighting Code 2010 & FIFA guideline 2020 about football pitch lighting

6.1 Design parameters for a sports facility

6.1.1 Level of competition :

Requirement of illuminace level on the field varies with the level of activities and competitions.The level of competition or type of activity can be categorized in five levels.[4]

1. **Class I** : Training & Recreation
2. **Class II** : Club Leagues
3. **Class III** : National level competition (Non-televised)
4. **Class IV** : National level competition (Televised)
5. **Class V** : International level of competition (Televised)

6.1.2 Horizontal illuminance :

Horizontal illuminance is an important parameter for the sports facility as it mainly establish the adaptation state of the eye and visual background for players, spectators and TV cameras.
In fact, if the required horizontal illumnance level is achieved, it will in turn help in achieving the vertical illuminance level.

6.1.3 Vertical illuminance :

Vertical illuminance in a sports field is essential to see the objects in vertical plane and to identify players from all direction. Generally four mutually perpendicular vertical planes at a height of 1.5m from the ground are considered for identification of players, officials and playing object in the field.
But adequate illuminance is also required to follow the flight of a ball at certain height above the playing field for the players, referee, spectator and cameras.

6.1.4 Camera vertical illuminance :

For televised events several fixed and field cameras are used in the football stadium. To create a clear and bright images, the TV camera needs vertical illuminance at 1.5m above the pitch surface facing towards the camera. Camera vertical plane is usually inclined to the pitch.

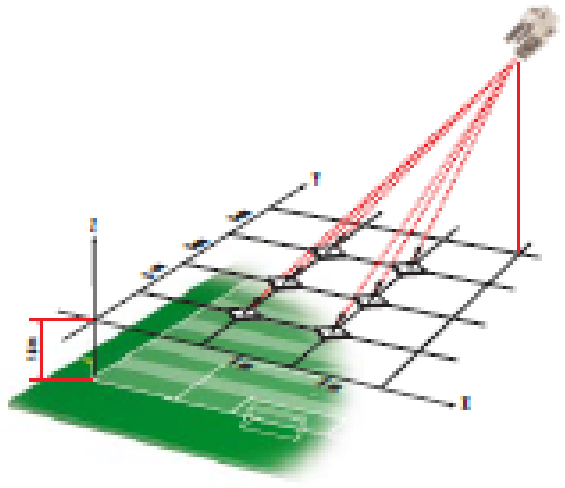


Figure 6.1: Camera position in the field [4]

6.1.5 Uniformity :

Good illuminance uniformity in horizontal and vertical planes in the field is required to eliminate visual adaptation problems for players, officials, spectators and adjustment problems for cameras for different directions of view.

If the uniformity level is not good enough, it not only affects the performance of the players, but also perturbs TV cameras to take clean images in certain zones on the field.

According to FIFA guideline the horizontal uniformity for visual performance, $U1_h = Eh_{min}/Eh_{max} >= 0.5$ and for visual comfort, $U2_h = Eh_{min}/Eh_{avg} >= 0.7$.

For vertical uniformity, $U1_v = Ev_{min}/Ev_{max} >= 0.5$ and for visual comfort, $U2_v = Eh_{min}/Eh_{avg} >= 0.6$.

6.1.6 Glare :

Glare is the sensation produced by the large luminance difference between the source luminance and background luminance in the field of vision. Limiting the glare is necessary in sports arena for the visual comfort and performance of players, officials and for the visual comfort of the spectators.Glare depends on the veiling luminance of the light source and veiling luminance of the background.

If the ratio of these two luminance is too high, it will cause visual discomfort or disability. The scale of discomfort glare ranging from 10 to 90. GR is required to be calculated for a number of grid points on the field.
FIFA recommends glare rating <50 for the football pitch. It can be controlled by positioning and aiming appropriate luminaires around the field.

6.1.7 Illuminance gradient :

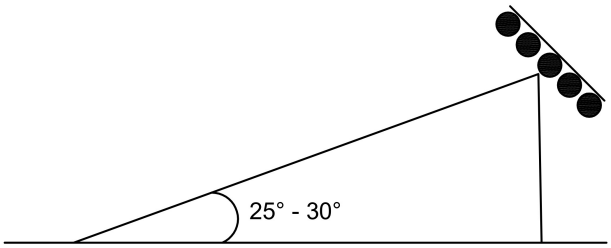
It is described as the change in horizontal illuminance value over a distance. Low illuminance gradient is always deserved in a play field to avoid discomfort glare and to get bright picture all along the field.High illuminance gradient may lead a player to misjudge the speed of the playing object.

6.1.8 Modelling and Shadow :

In any sports field good modelling of playing objects and players face is essential to deliver a pleasant impression for players, spectators and TV cameras.

The modelling effect is produced by the proper combination of light and shadow. In a football pitch the modelling effect is created by focusing light from multiple directions so that there is a variation of illuminance at different vertical planes.

However to ensure good face modelling of the players, the luminaires should be positioned in such a way that those make an optimum angle 25° - 30° to the perpendicular of the pitch perimeter.



6.1.9 Colour appearance and colour rendering :

The colour appearance or colour temperature (T_c) of the lamp can be described as the colour impression received when looking at the lamp.
The colour rendering (R_a) of a light source can be described as the ability of the light source to reveal and reproduce the surface colour of the illuminanted object faithfully.[3]

For filming and TV board-casting, above two parameters of the light source are equally important as that of adequate illuminance level and uniformity of illuminance.
The colour temperature between the range of 3000K - 6200K and colour rendering index (R_a) >= 80 are suitable for television network and filming.

6.2 FIFA guideline about luminaire mounting [1]

According to FIFA lighting guide 2020, following standards to be followed for pitch illuminance.

1. Corner masts are to be positioned at an angle of 120° from the goal line and 120° from the pitch line. The mast at the Corner of the pitch should be installed at a distance of more than 12m to avoid excessive glare.

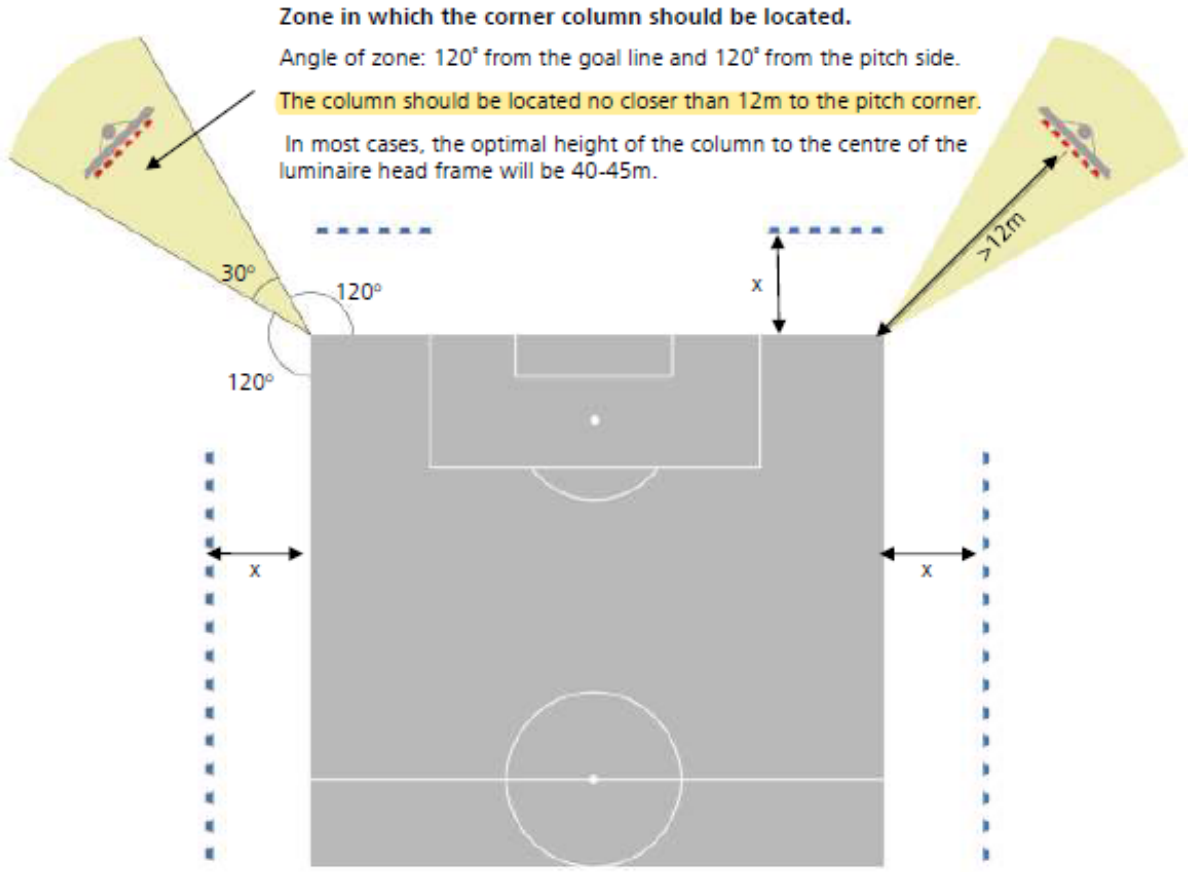


Figure 6.2: Mounting position of corner pole [1]

2. In order to achieve the vertical illuminance around the perimeter of the pitch, the luminaires should have a mounting position with a minimum lateral distance from the pitch perimeter of more than 12m($x >= 12m$).[1]

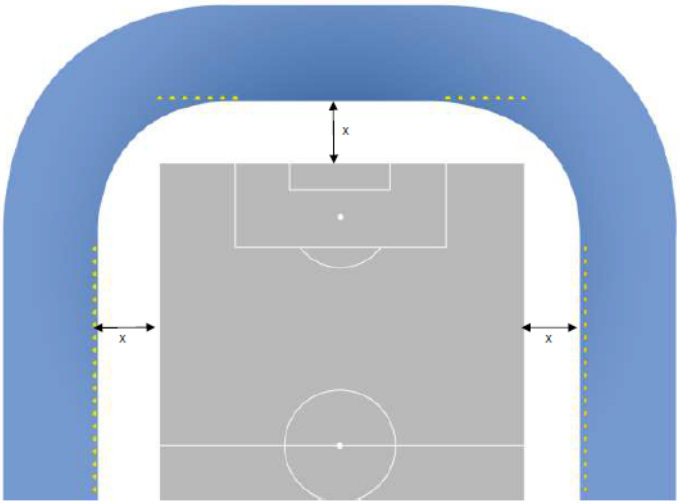


Figure 6.3: Rim light mounting position [1]

3. In order to eliminate the discomfort glare being experienced by the players and officials, the luminaires elevation angle should be less than 70° for HID luminaires and less than 60° for LED luminaires.

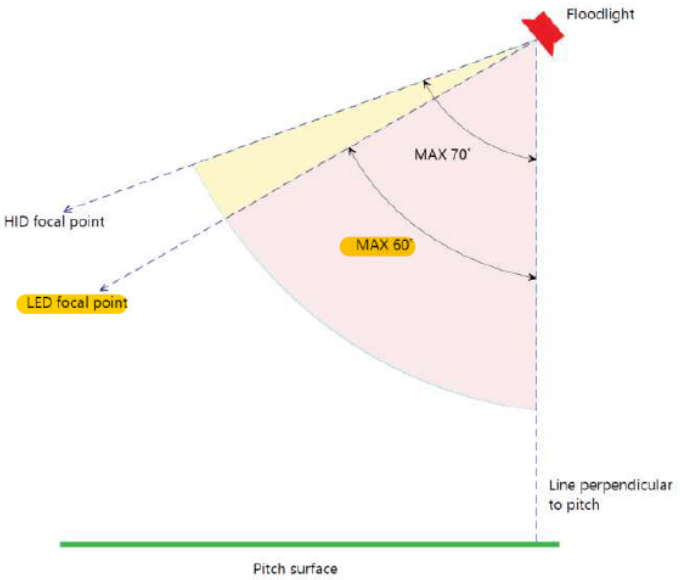


Figure 6.4: Elevation angle of luminaire [1]

4. The luminaires are to be mounted at an angle of no less than 25° and no more than 45° above the centre of the pitch in order to achieve improved vertical illuminance around the perimeter of the pitch.

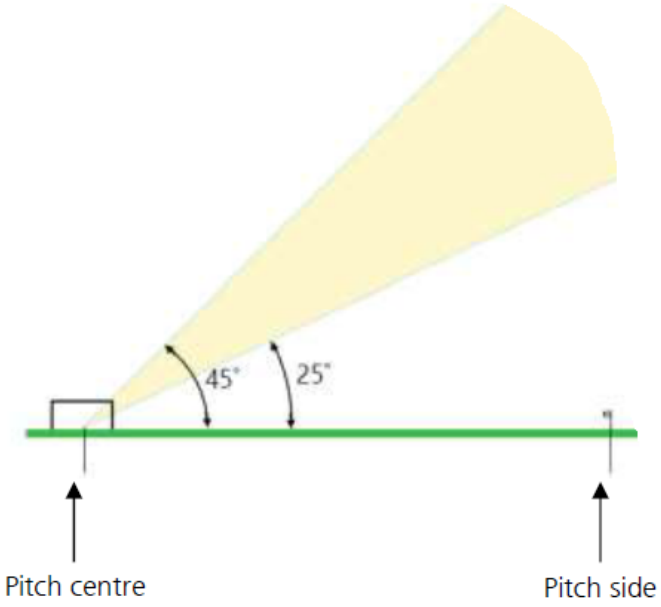


Figure 6.5: Subtended angle of light beam at pitch centre [1]

5. The luminaires are to be mounted at least 20 - 25m above the pitch surface to avoid visual discomfort glare.

6.3 Lighting standard of football pitch as per FIFA guideline 2020 and NLC 2010

6.3.1 For non-televised matches [3] :

The table 6.1 depicts the criteria of lighting level for non-televised event.

Table 6.1: Lighting level for non-televised events as per NLC 2010[3]

Activity Level	Class	Horizontal Eh ave (Lux)	Uniformity (U2)	Glare rating (GR)	Lamp colour rendering (Ra)
National games	I	500*	0.7	<= 50	>= 60
Regional or local clubs	II	200*	0.6	<= 50	>= 60
Training & recreation	III	75*	0.5	<= 50	>= 20

Note :

- Illuminance value indicated are maintained values.
- Illuminance gradient shall not be more than 25% each 5 meters.

6.3.2 For televised matches [1,3] :

The following table describe the criteria of lighting level for Televised events.
The data given in the table are taken from FIFA Guideline 2020 and National Lighting Code 2020.[1,3]

Table 6.2: Lighting level for televised events

Class	Calcu lation toward	Vertical Illuminance			Horizontal Illuminance			Properties of Lamps	
		Ev. Avg.	Uniformity		Eh. Avg.	Uniformity		Colour tem-pera-ture	Colour ren-dering
		Lux	U1	U2	Lux	U1	U2	Tc	Ra
Inter-natio-nal	i. Slow motion camera	1800	0.5	0.7	1500 to 3000	0.6	0.8	4200K to 6200K	=>80
	ii. Fixed camera	1400	0.5	0.7					
	iii. Mobile Cameras (at pitch level)	1200	0.3	0.5					
Natio-nal	i. Fixed camera	1000	0.4	0.6	1000 to 2000	0.5	0.7	4200K to 6200K	=>80

Note :

- Illuminance values indicated are maintained value.
- A maintenance factor of 0.8 for HID and 0.90 for LED are recomended.
- Illuminance gradient shall not be more than 25% each 5 meters.
- Glare rating (GR) should be <50.

Chapter 7

Lighting design for football field

7.1 Design input

7.1.1 Size and layout of football pitch :

As per FIFA, the length of the football pitches should be between 90 to 120m and the width of the pitch should be between 45 to 90m.
The dimensions of field of play are 105m x 68m as per FIFA. According to the guideline the following norms are to be followed —

- The field of play should be **rectangular** and should be marked with continuous lines.
- The field surface will be level and there will be no change in surface characteristics at least 2m beyond the touch lines and goal lines.
- Advertising board may be placed at a distance of 5m beyond each goal line and 4m beyond each touch line.

However, in my thesis work I have considered field dimensions 106m x 68m.

7.1.2 Recommended lighting values for the design field as per FIFA guideline :

The target values in respect of the following lighting parameters are required to be achieved for the designed football pitch as per FIFA guideline.[1]

1. Maintained average Horizontal illuminance (Eh_{avg}) :

i. Minimum >= 1500 lux
ii. Average >= 2500 lux
iii. Uniformity, (U1h) >= 0.5 for visual performance
iv. Uniformity, (U2h) >= 0.7 for visual comfort

2. Average camera Vertical illuminance ($Evcam_{avg}$) :

i. Minimum >= 1000 lux
ii. Average >= 1500 lux
iii. Uniformity, (U1h) >= 0.5
iv. Uniformity, (U2h) >= 0.6

3. Eh_{avg}/Ev_{avg} = 0.5 - 2.0 (Required for good visual ambience and good picture quality)

4. Colour Temperature (T_c) should be 4200 - 6200K.

5. Colour Rendering (R_a) >= 80.

6. Glare Rating (R_G) < 50.

7. Illuminance gradient should be <= 25% change per 5m.

7.2 Design tools

7.2.1 Auto CAD :

Auto CAD is a computer aided design and drafting software program used for 2D drawings and 3D modelling. It is a powerful tools for creation and modification of geometric models for all sort of structures and objects. These attributes make wide use of Auto CAD in the field of architecture and engineering.

Auto CAD works with its native file DWG word drawing which contains 2 or 3 dimensional vector graphics. Auto CAD supports DXF (Drawing exchange format) file which is generally used to share design across different CAD programmes.

7.2.2 DIALux 4.13 :

DIALux is a free lighting design software used to calculate, visualize and quantitative analysis of lighting design for indoor and outdoor spaces.

It can import a number of 3D models including DWG,DXF files and IES files consisting photo-metric data of various light manufactures. It can calculate energy consumption of lighting system based on the selected luminaires and their usage time.

7.3 Lighting design methodology

7.3.1 Meeting the client :

Before taking up the lighting design work for a specific football ground, it is essential to get the layout diagram of the stadium from the client. Interaction with the client helps to know the need of the client and his views in respect of the utilisation of sports facility.

7.3.2 Site Visit :

As each sports field is unique in nature, the design of lighting for a particular stadium is also unique. Therefore, visiting the venue is essential to collect data such as dimensions of the field, stand orientation, open space beyond the play field etc.

7.3.3 Field layout diagram using Auto CAD :

The collected data are used to draw field layout diagram using Auto CAD. Masts locations are decided according to the FIFA guideline and marked the positions on the layout diagram.

7.3.4 Calculation of mast height :

Mast height is determined with the help of empirical formula $\mathbf{H{=}D.tan}\alpha$, where α is the subtended angle of luminaire at the centre of the pitch and D is the distance between centre of the pitch and high mast.

7.3.5 Importing DWG file in DIALux :

The DWG file is imported to DIALux 4.13 program. Placing mast at the calculated location on the field. Now select the calculation grid and set the dimension of each grid, i.e, 5m x 5m.

7.3.6 Placing main TV camera :

Main TV camera is mounted 6m away from the field side line towards the main stand and at a height of 10m above the field. Cameras are also provided behind the goal lines.

7.3.7 Importing IES file from manufacturer catalogue to DIALux :

IES files of selected luminaires are imported in DIALux. Now setting the mounting height and quantity of luminaires per row. Put the command "mirror horizontal" and "mirror vertical" to get the beam distribution throughout the field.

7.3.8 Aiming of luminaires :

To get the target illuminance value and value of other lighting parameters recommended by FIFA, luminaires are to be aimed on the field suitably.

7.4 Selection of luminaires :

In sports lighting appropriate luminaire selection is very much important factor among other factors that contributing to specific lighting quality over the play field. Other factors are –

- Proper positioning of mast around the field.
- Proper layout of luminaires at correct height on the mast.
- Accurate aiming of luminaires towards the pitch.

A luminaire used for sports field should have following characteristic to ensure good quality light around the field.

- High light output ratio and good light distribution property.
- High lamp efficacy and system efficacy.
- High degree of protection against external mechanical impact.
- Moderate weight and size.
- Energy efficient.
- Long service life.
- Environmental friendly.

For football pitch lighting design with 4 & 6 poles arrangement, I have selected 1kW LED flood light make of SILVERSUN. The specification of the luminaire with its luminous intensity distribution diagram is given below.

The colour temperature of sports luminaire is selected between 4000K to 6500K to reduce the apparent colour changes in the scene of the sport arena when the daylight is gradually replaced by the artificial light.[15]

FLC1000FW

Sports LED floodlight model FLC1000FW branded Silversun, 4 modules, diameter 52cm, beam angle 25°. Black aluminum body and polycarbonate optical lens diffuser. Colour temperature 5700K, luminous flux 132.000 lm, color rendering index >70, power 1000W, 100-277 VAC / 50-60 Hz and protection indexes IP65 and IK10. Dimensions diameter 520mm x depth 515mm and weight 23 Kg. Installation bracket included.

LUMINOUS DATA

Luminous flux	132.000 lm
Efficiency	132 lm/W
Colour rendering index CRI	≥70
Colour temperature	5700K
Colour chromatic (sdcm)	3,4

ELECTRICAL DATA

Power	1000W
Rated voltage	100-277V AC
Frequency	50/60Hz
Power factor	≥0,95
Harmonic distortion THD	<20%
Inrush current	26A
Max units per MCB C16	1
Dimmable	1-10V
Driver	Internal
Class protection	Class I

OPTICAL DATA

Beam angle	25°
Diffuser model	Optical Lens
Diffuser material	Polycarbonate

MECANICAL DATA

Body material	Aluminum
Body colour	Black RAL9004
IP protection rate	IP65
IK protection rate	IK10

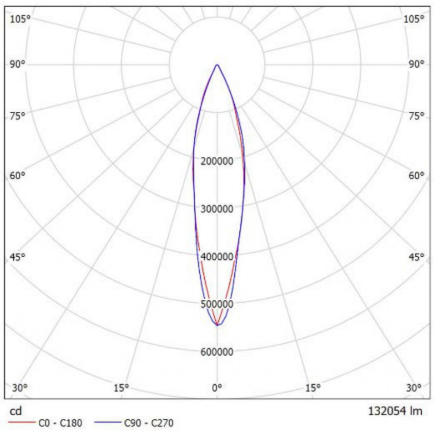
FUNCTIONAL DATA

Working temperature	-30ºC a 40ºC
Lifespan (L70B10 25º)	>163.000h

LOGISTICAL DATA

EAN code	8436546699361
Device dimensions	Ø520x515mm
Device weight	23 kg
Units per box	1
Box dimensions	620x570x415mm
Box weight	27 kg

DISTRIBUTION



DIMENSIONS

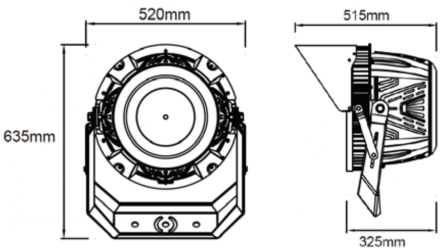
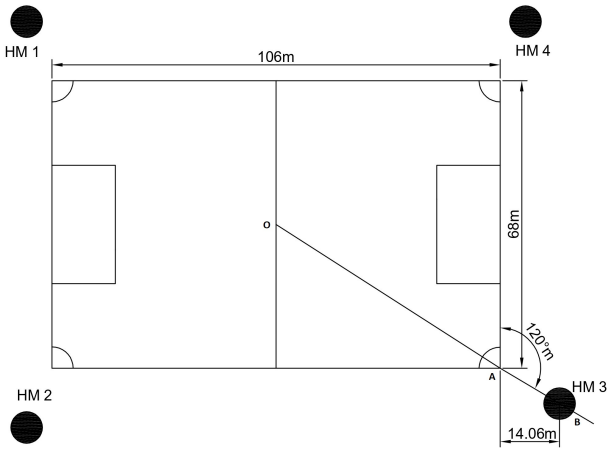
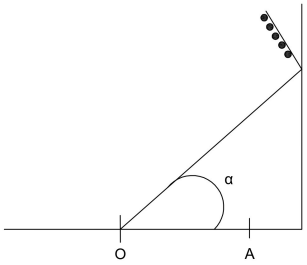


Figure 7.1: Specification of selected luminaire

7.5 Estimation of pole height and pole position for 4 pole arrangement :

It is seen for the drawing below that the poles are to be placed at a distance of 14m from the corner to offset it from the goal line by 120°.





Distance between point O and A is –

$$OA = \sqrt{(68/2)^2 + (106/2)^2} m = 63m$$

Hence, D = OB = 63+14 = 77m, so corner poles will be mounted at a distance of 77m from the centre of the pitch.
Let the angle between pitch centre and bottom most cross arm on the head frame, $\alpha = 25°$.

So Height of the mast,

$$\mathbf{H = D.tan}\alpha$$

$$= \ 77m \ x \ tan25 \ = \ 35.88m \approx 36m.$$

7.6 Estimation of electrical power requirement for the pitch with 4 pole arrangement :

As per FIFA guideline, the average horizontal illuminance for class A football stadium should be equal or more than 2500 lux.
We know,

$$Eh_{avg} = \frac{\phi \times \eta \times C.O.U \times M.F}{Area\ of\ the\ field}$$

Φ = Luminous flux given by selected luminaire = 132054 lm
η = No. of luminaire
taken, C.O.U = 0.5
and, MF = 0.8

$$So, 2500 = \frac{132054 \times \eta \times 0.5 \times 0.8}{106 \times 68}$$

$$\eta = \frac{2500 \times 106 \times 68}{132054 \times 0.5 \times 0.8} = 341.14 \approx 342\ nos.$$

Luminaire per pole = 342/4 = 85.5 , say 86 Nos.
Placing 86 nos. luminaires in each pole, (for 4 poles = 86 x 4 = 344 nos.) in DIALux, we got Eh_{avg} = 2238 lux.

But Eh_{avg} should be more than 2500 lux. Therefore, no. of luminaires required :

$$= \frac{2500}{2238} \times 344 = 384\ nos.$$

But actually to acheive $Eh_{avg} > 2500$ Lux, 392 nos. luminaires are required.
So,Luminaires in each pole = 392/4 = 98 nos.
Power requirement for luminaires in each pole = **98 kW.**

7.7 Layout diagram of distribution of luminaires on Head-frame (4 pole arrangement) :

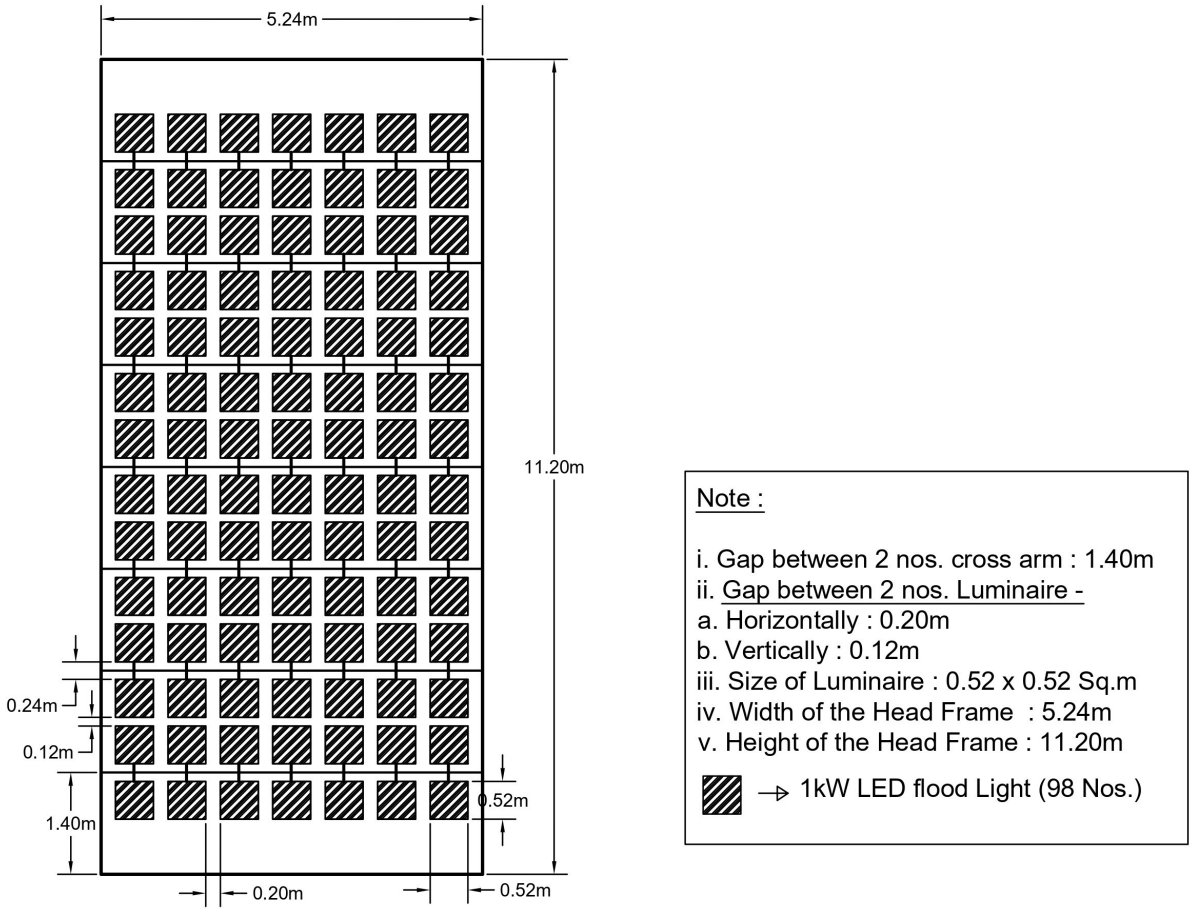


Figure 7.2: Distribution of luminaires on Head frame

Luminaire per mast = 98 nos.
No. of cross arm in the head frame = 7
So, each cross arm contains 7 x 2 = 14 nos. luminaires.

7.8 Estimation of pole height and pole position for 6 pole arrangement :

Lateral distance of the side pole from the side line is taken as 12m as recommended by FIFA.
So, distance of side pole from the centre = 34 + 12 = 46m.
Considering the subtended angle between bottom most cross arm of the head frame & the centre of the pitch α= **33.5**°.

Then height of the pole –

$$H = D.tan\alpha$$
$$= 46m \times tan33.5^\circ = 30.40\ m$$

Keeping the same pole height for corner poles too.

7.9 Estimation of electrical power requirement for the pitch with 6 pole arrangement :

As per the recommendation of FIFA, the average horizontal illuminance (Eh_{avg}) would be equal or more than 2500 lux.

$$Eh_{avg} = \frac{\phi \times \eta \times COU \times MF}{Area\ of\ the\ field}$$

Φ = Luminous flux given by selected luminaire = 132054 lm
η = No. of luminaire
taken, C.O.U = 0.5
and, MF = 0.8

$$So, 2500 = \frac{132054 \times \eta \times 0.5 \times 0.8}{106 \times 68}$$

$$\eta = \frac{2500 \times 106 \times 68}{132054 \times 0.5 \times 0.8} = 341.14 \approx 342\ nos.$$

But placing 342 nos. luminaires of 1kW output in DIALux, we obtained 2274 lux. Therefore, the no. of luminaires required to be increased for obtaining desired Eh_{avg}.

$$\eta = \frac{342 \times 2500}{2274} = 375.98 \approx 376\ nos.$$

Luminaire arrangement per mast :

- For Corner Mast :

i. Taken 7 cross arm on the head frame

ii. In cross arm 1,4 & 7 there are 9 nos. luminaires in each cross arm

iii. In cross arm 2,3,5 & 6 there are 8 nos. luminaires in each cross arm

Therefore, in 1 corner mast, no. of luminaires = 9 x3 + 8 x 4 = 27 + 32 = 59 nos.

In 4 corner masts, no. of luminaires = 59 x 4 = 236 nos.

- For Side Mast :

i. There are 7 cross arm and each row contains 10 luminaires.

ii. So, in 1 side mast, no. of lumianires = 7 x 10 = 70 nos.

iii. For 2 nos. side mast, no. of luminaires = 70 x 2 = 140 nos.

So, total luminaires mounted on 6 masts = 236 + 140 = **376** nos.

- Power requirement per mast :

i. For each corner mast, power requirement = 59 x 1kW = 59 kW

ii. For each side mast, power requirement = 70 x 1kW = 70 kW

Therefore, total power requirement for all 6 high mast —-

$$= 59 \times 4 + 70 \times 2 \ = 376 \ kW$$

7.10 Layout diagram of distribution of luminaires on Head-frame (6 pole arrangement):

- **For corner high mast :**

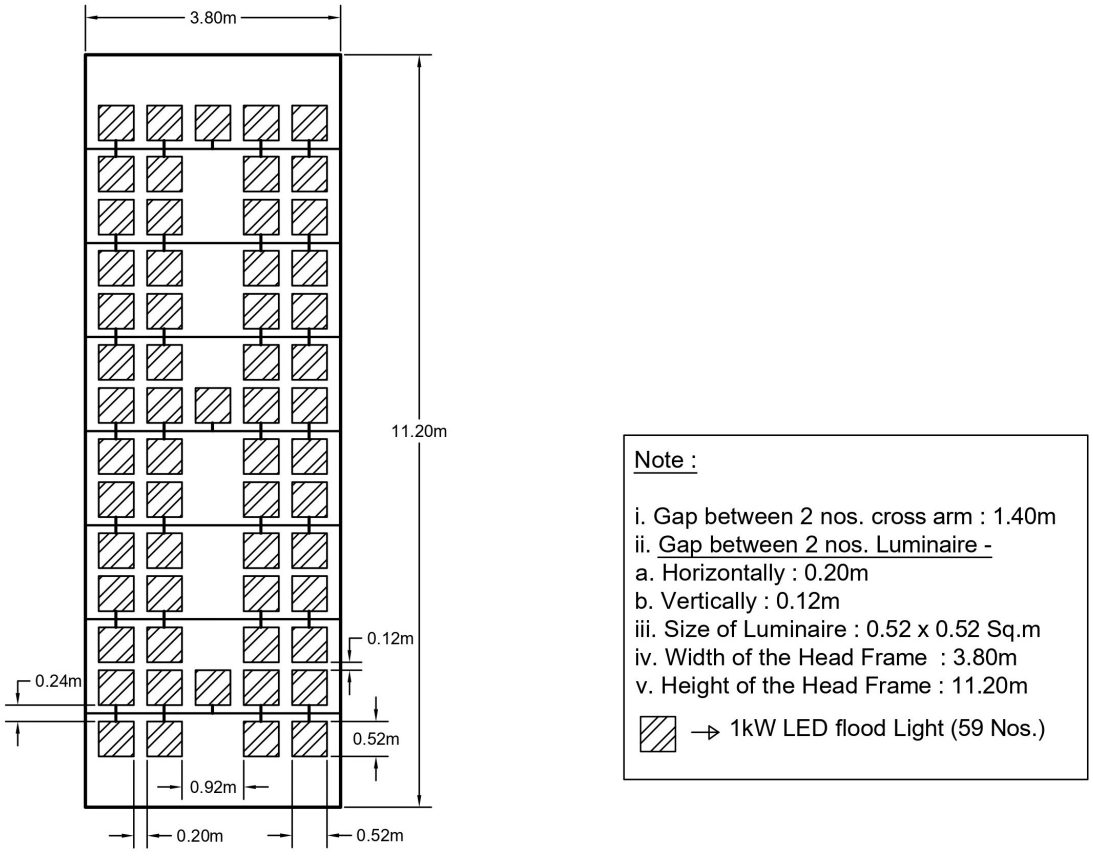


Figure 7.3: Distribution of luminaires on Head frame

- **For Side high mast :**

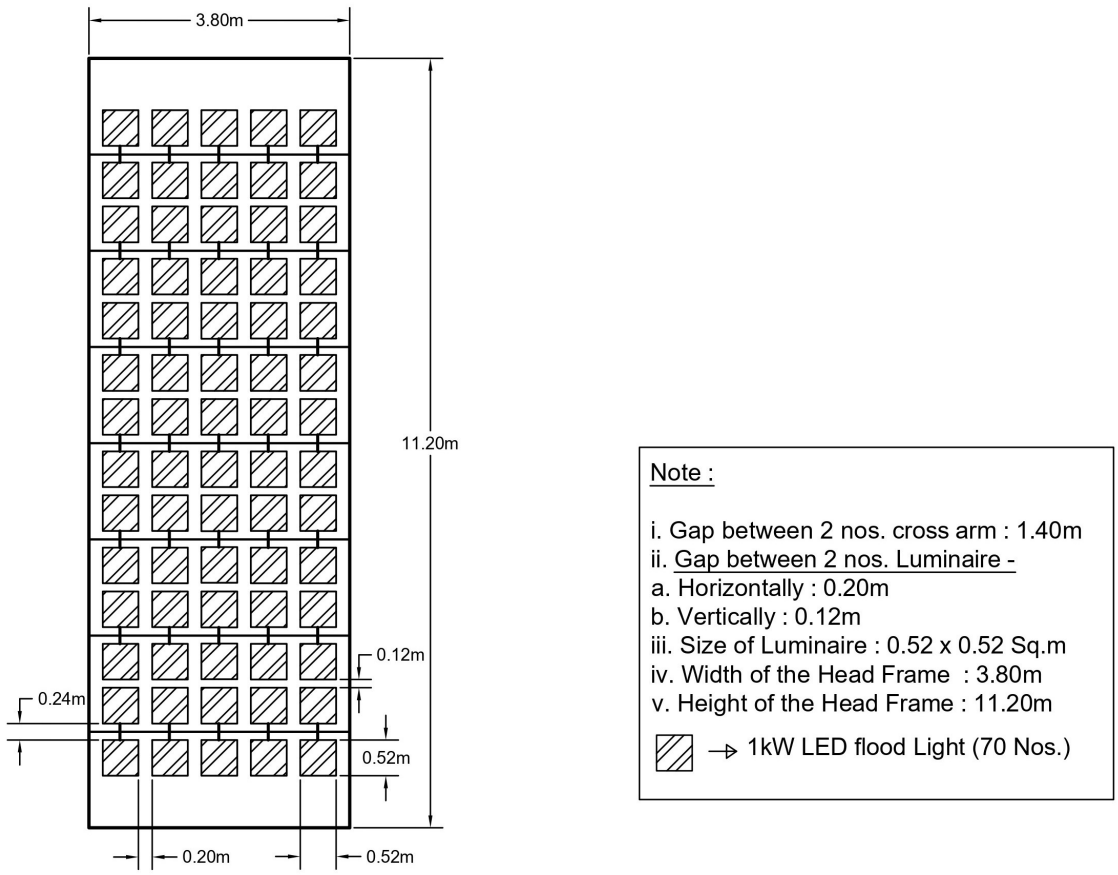


Figure 7.4: Distribution of luminaires on Head frame

Chapter 8

Lighting Design – Evaluation of different lighting parameters using DIALux

8.1 4 Pole arrangement :

Field layout made in AutoCAD is imported DIALux 4.13 and ddifferent data like IES file of luminaires used, no. of luminaires used in each mast, luminaire orientation etc. pole position & light loss factor, grid size etc. are given to the DIALux program as an input data.

Then carrying out aiming of luminaires mounted on the head frames to get the target lighting value as specified by FIFA guide line.

Result obtained :

1. Horizontal illuminance :
   - Eh_{avg} = **2627 lux**
   - Eh_{min} = 1847 lux
   - Eh_{max} = 3223 lux
   - $U1_h$ = 0.57
   - $U2_h$ = 0.70
   - Gradient graphics = Max 18% . (each 5m)
2. Camera Vertical illuminance :
   - Ev_{avg} = **1855 lux**
   - Ev_{min} = 1119 lux
   - Ev_{max} = 2347 lux
   - $U1_h$ = 0.48
   - $U2_h$ = 0.60
3. Glare rating = Max. 41
4. $Eh_{avg}/\ Ev_{avg}$ = 1.41

Football stadium lighting according to FIFA (4 Pole Arrangement)

A. Installation Parameter :

Field Length : 106m
Field Width : 68m
Pole distance from corner : 14m
Mast Height : 36.40 m

According to mathematical calculation total no of luminaire : 392 Nos. (Appx)
Lamp/pole : 98 Nos.
lamp/Row (7 Rows) : 14 Nos.

B. Target Design Parameter :

1.Average Horizontal Illuminance (Ehavg) : 2500 lux, min : 1500 lux
2. Average Vertical Illuminance (EVavg) : 1500 lux , min : 1000 lux
3. Uniformity, U1 : >=0.50
U2 : >=0.70
4. Glare rating (GR) : < 50
5. Gradient Graphics : =<25% (each 5m)

Date: 11.07.2023
Operator:

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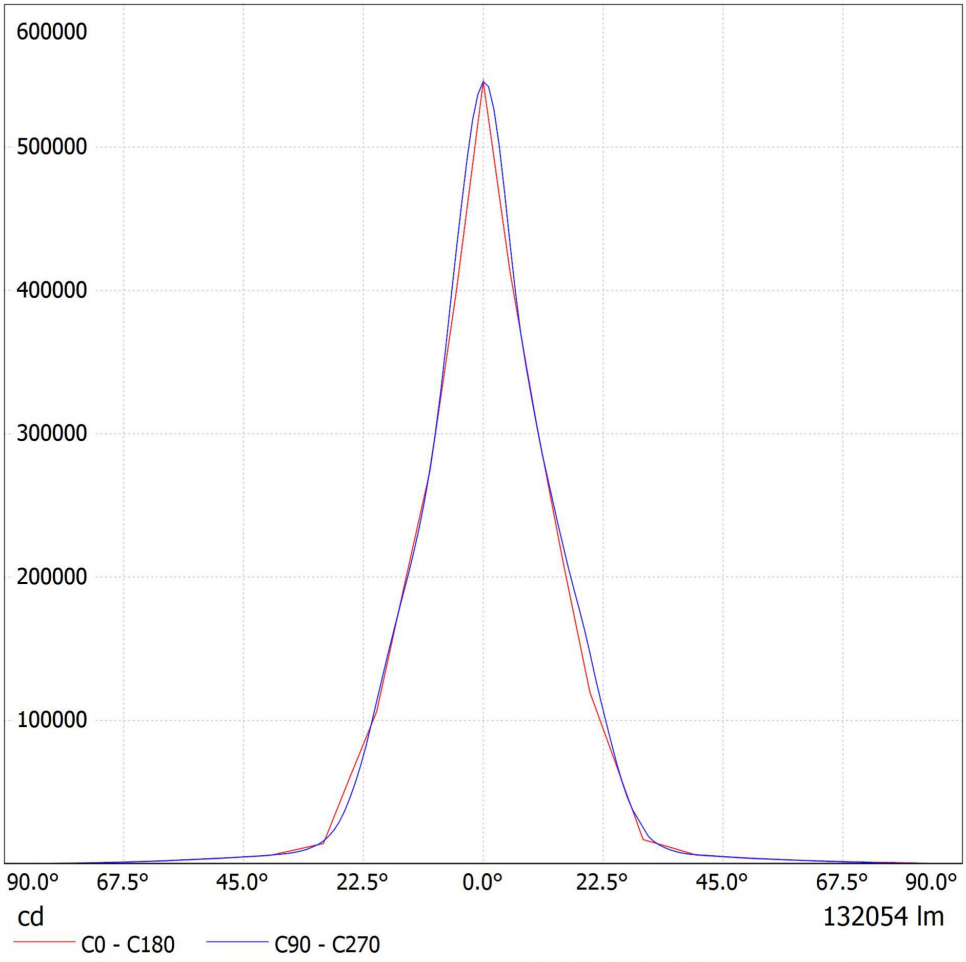
SILVERSUN FLC1000FW FloodLight Round HighMast 25Âº IP65 1000W 5700K / LDC (Linear)

Luminaire: SILVERSUN FLC1000FW FloodLight Round HighMast 25Âº IP65 1000W 5700K
Lamps: 1 x



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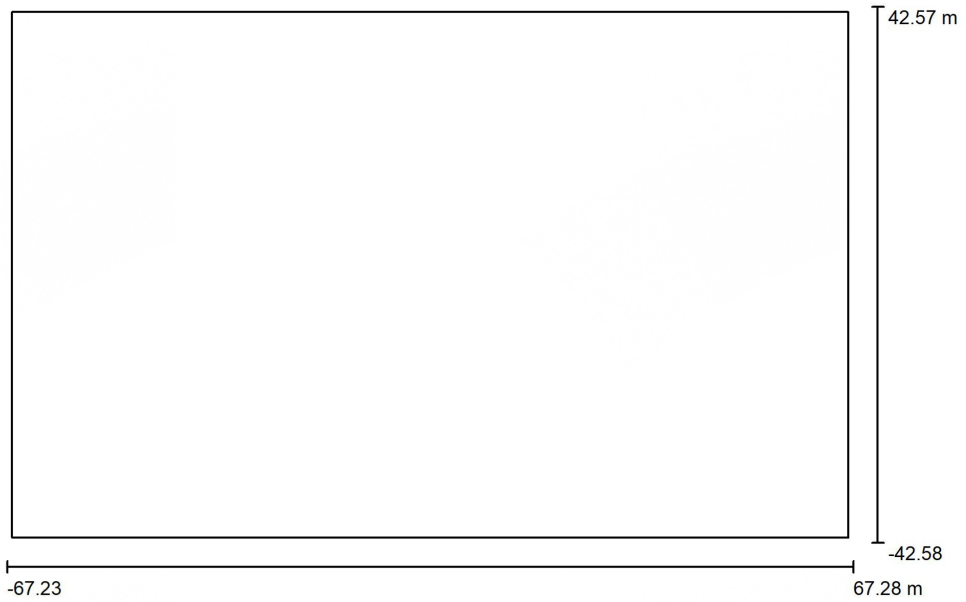
Football Ground / Planning data



Light loss factor: 0.80, ULR (Upward Light Ratio): 5.5%

Scale 1:962

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	392	SILVERSUN FLC1000FW FloodLight Round HighMast 25Â° IP65 1000W 5700K (1.000)	132054	132054	1009.6
			Total: 51765304	Total: 51765304	395775.0

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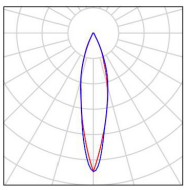
Football Ground / Luminaire parts list

392 Pieces	SILVERSUN FLC1000FW FloodLight Round HighMast 25Â° IP65 1000W 5700K Article No.: FLC1000FW Luminous flux (Luminaire): 132054 lm Luminous flux (Lamps): 132054 lm Luminaire Wattage: 1009.6 W Luminaire classification according to CIE: 100 CIE flux code: 94 98 100 100 100 Fitting: 1 x User defined (Correction Factor 1.000).	See our luminaire catalog for an image of the luminaire.	

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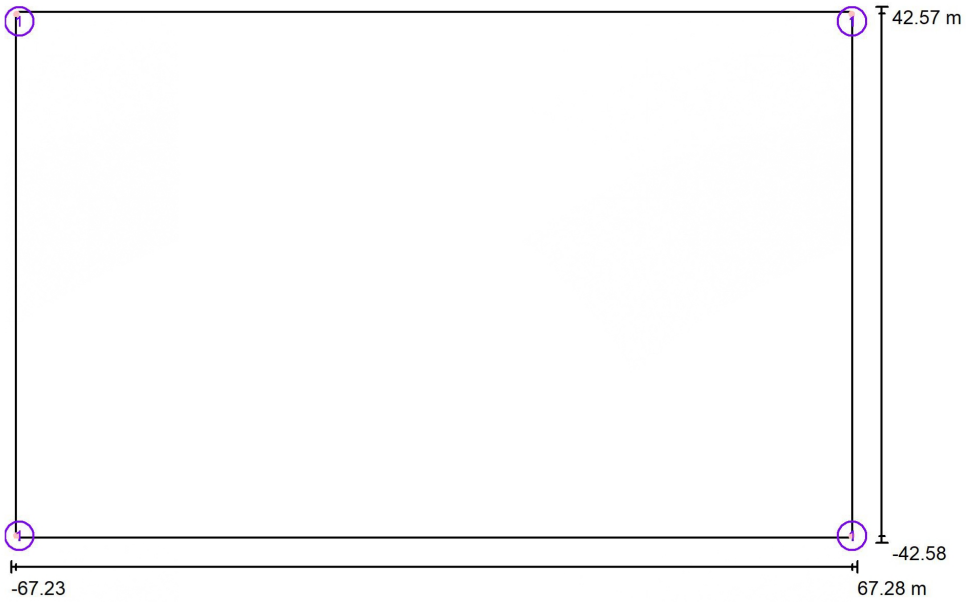
Football Ground / Luminaires (layout plan)



Scale 1 : 962

Luminaire Parts List

No.	Pieces	Designation
1	392	SILVERSUN FLC1000FW FloodLight Round HighMast 25Â° IP65 1000W 5700K

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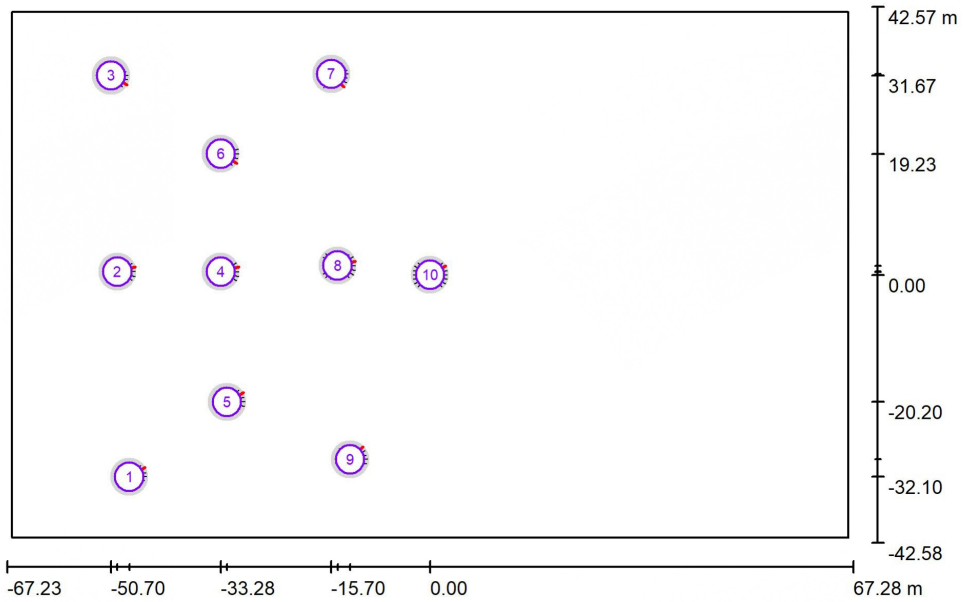
Football Ground / GR Observer (Results Overview)



Scale 1 : 962

GR Observerlist

No.	Designation	Position [m]			Viewing sector [°]				Max
		X	Y	Z	Start	End	Increment	Slope angle	
1	GR Observer 14	-47.800	-32.100	1.500	0.0	360.0	15.0	-2.0	39 2)
2	GR Observer 14	-49.700	0.500	1.500	0.0	360.0	15.0	-2.0	40 2)
3	GR Observer 14	-50.697	31.674	1.500	0.0	360.0	15.0	-2.0	39 2)
4	GR Observer 14	-33.279	0.474	1.500	0.0	360.0	15.0	-2.0	40 2)

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Football Ground / GR Observer (Results Overview)

GR Observerlist

No.	Designation	Position [m]			Viewing sector [°]				Max
		X	Y	Z	Start	End	Increment	Slope angle	
5	GR Observer 14	-32.279	-20.198	1.500	0.0	360.0	15.0	-2.0	41 2)
6	GR Observer 14	-33.279	19.232	1.500	0.0	360.0	15.0	-2.0	40 2)
7	GR Observer 14	-15.700	31.900	1.500	0.0	360.0	15.0	-2.0	38 2)
8	GR Observer 14	-14.700	1.431	1.500	0.0	360.0	15.0	-2.0	40 2)
9	GR Observer 14	-12.700	-29.343	1.500	0.0	360.0	15.0	-2.0	38 2)
10	GR Observer 14	0.000	0.000	1.500	0.0	360.0	15.0	-2.0	39 2)

2) The calculated equivalent veil luminance of the environment is based on the assumption of a complete diffuse reflection behavior of the environment (acc. EN 12464-2).

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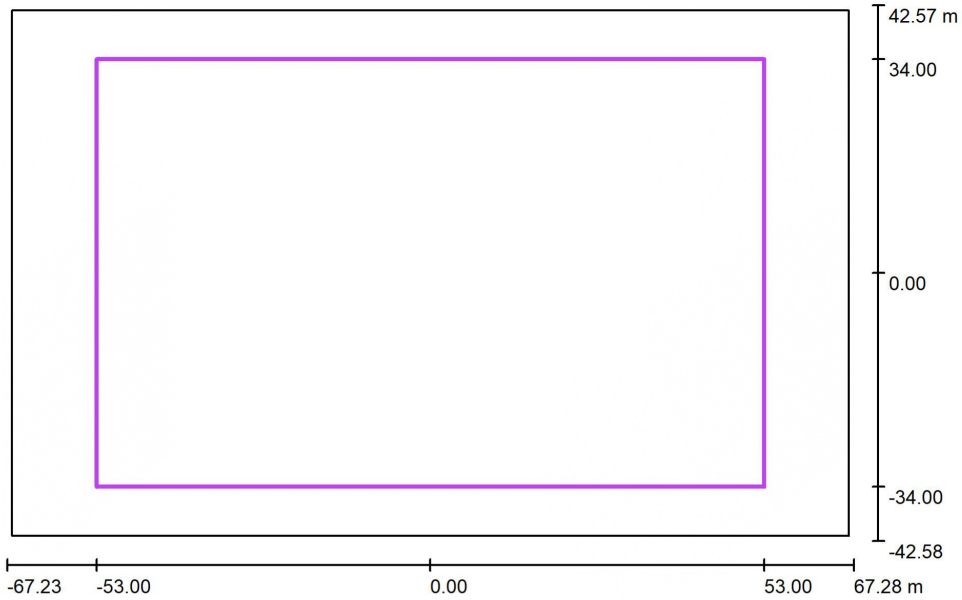
Football Ground / Calculation Grid Horizontal / Summary



Scale 1 : 962

Position: (0.000 m, 0.000 m, 0.000 m)
Size: (106.000 m, 68.000 m)
Rotation: (0.0°, 0.0°, 0.0°)
Type: Normal, Grid: 22 x 14 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	horizontal	2627	1847	3223	0.70	0.57	/	0.000	/

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

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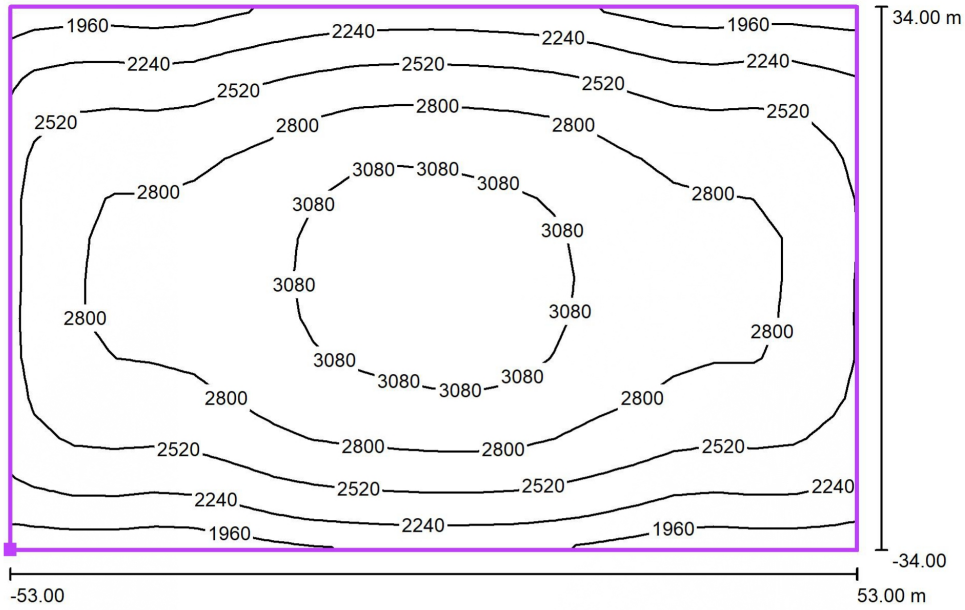
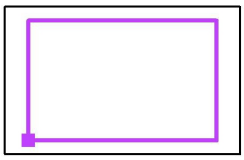
Football Ground / Calculation Grid Horizontal / Isolines (E, Horizontal)



Values in Lux, Scale 1 : 758

Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)



Grid: 22 x 14 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
2627	1847	3223	0.70	0.57

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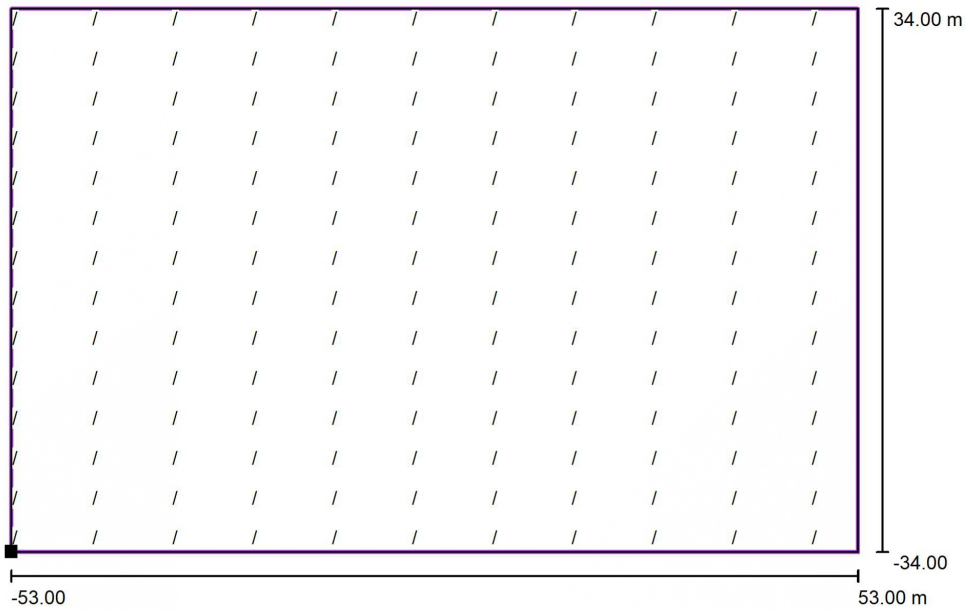
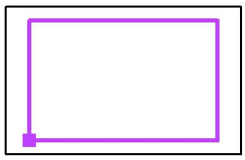
Football Ground / Calculation Grid Horizontal / Gradient Graphics (E, Horizontal)



Values in %, Scale 1 : 758

Not all calculated values could be displayed.

Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)



Maximum Change: 18%
Selected Limit Value: 25% (Values below this limit value are not output.)
Distance for the Gradient Grid: 5.000 m

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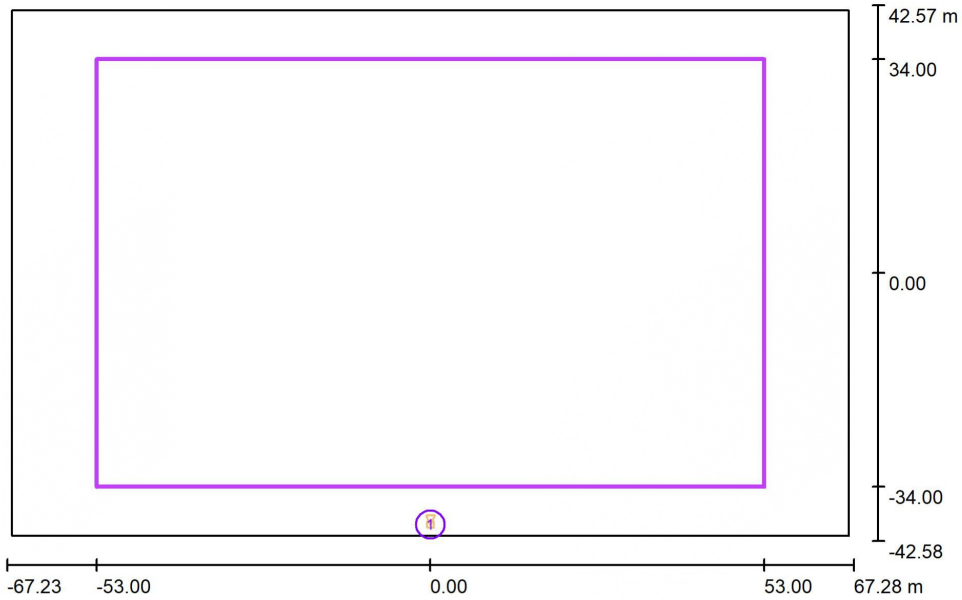
Football Ground / Calculation Grid Ecam / Summary



Scale 1 : 962

Position: (0.000 m, 0.000 m, 0.000 m)
Size: (106.000 m, 68.000 m)
Rotation: (0.0°, 0.0°, 0.0°)
Type: Normal, Grid: 22 x 14 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	Camera	1855	1119	2347	0.60	0.48	/	1.000	1

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

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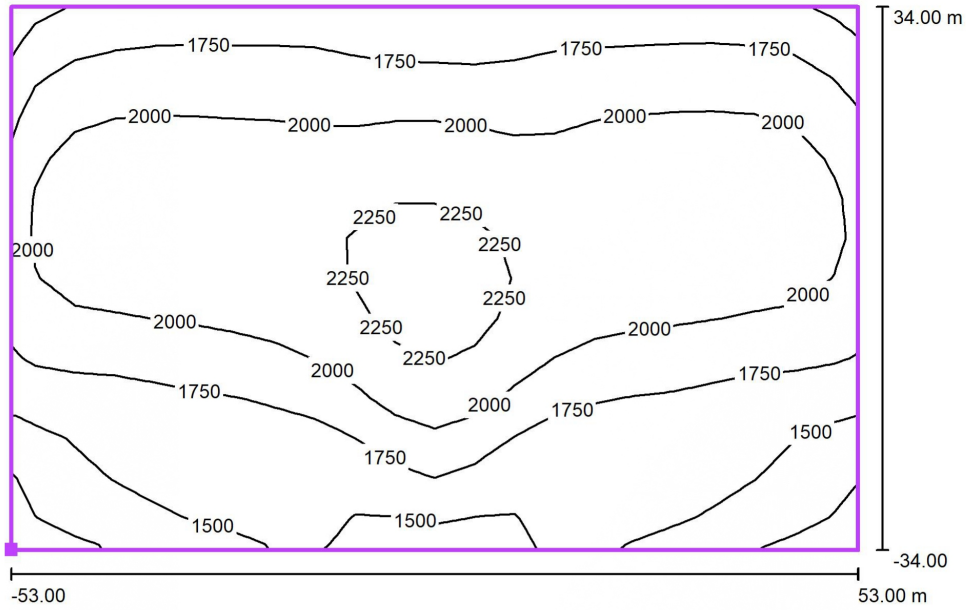
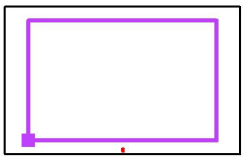
Football Ground / Calculation Grid Ecam / Isolines (E, Camera)



Values in Lux, Scale 1 : 758

Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)
Camera Position: (0.000 m, -40.000 m, 10.000 m)



Grid: 22 x 14 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
1855	1119	2347	0.60	0.48

8.2 6 Pole arrangement :

All input data given to DIALux program and resultt obtained as follow —

Result obtained :

1. Horizontal illuminance :
    - Eh_{avg} = **2504 lux**
    - Eh_{min} = 1760 lux
    - Eh_{max} = 3326 lux
    - $U1_h$ = 0.53
    - $U2_h$ = 0.70
    - Gradient graphics = Max 15% (each 5m)
2. Camera Vertical illuminance :
    - Ev_{avg} = **2145 lux**
    - Ev_{min} = 1586 lux
    - Ev_{max} = 3053 lux
    - $U1_h$ = 0.52
    - $U2_h$ = 0.74
3. Glare rating = Max. 41
4. $Eh_{avg}/\ Ev_{avg}$ = 1.16

Football stadium according to FIFA (6 Pole Arrangement)

A. Installation Parameter :
Field Length : 106m
Field Width : 68m
Distance between side pole and centre of the pitch : 46m
Mast Height : 30.40m
Corner mast : No. of rows = 7
No. of luminaire for 3 rows =3x9 = 27 nos.
No. of luminaire for 4 rows = 4 x 8 = 32 nos.
So, for 4 corner mounted poles the no. of luminaire = 59 x 4 = 236 nos.

Side mast :
No. of rows = 7
Luminaire per pole = 10 , So, luminaire per mast = 10 x 7 = 70 nos. No. of luminaires for 2 poles = 70 x 2 = 140 Nos.
So, total no. of luminaire = 236 + 140 = 376 Nos.

Target Design Parameter :
1.Average Horizontal Illuminance (Ehavg) : 2500 lux, min : 1500 lux
2. Average Vertical Illuminance (EVavg) : 1500 lux , min : 1000 lux
3. Uniformity, U1 : >=0.50
U2 : >=0.70
4. Glare rating (GR) : < 50
5. Gradient Graphics : = <25% (each 5m)

Date: 11.07.2023
Operator:

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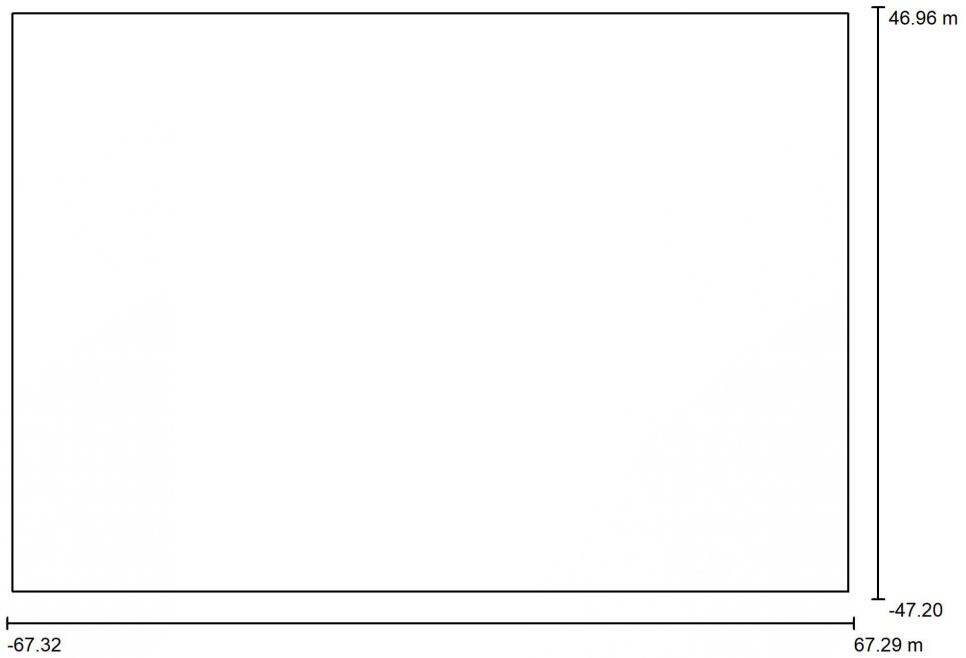
Football Ground / Planning data



Light loss factor: 0.80, ULR (Upward Light Ratio): 6.5%

Scale 1:963

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	376	SILVERSUN FLC1000FW FloodLight Round HighMast 25Â° IP65 1000W 5700K (1.000)	132054	132054	1009.6
			Total: 49652434	Total: 49652434	379620.9

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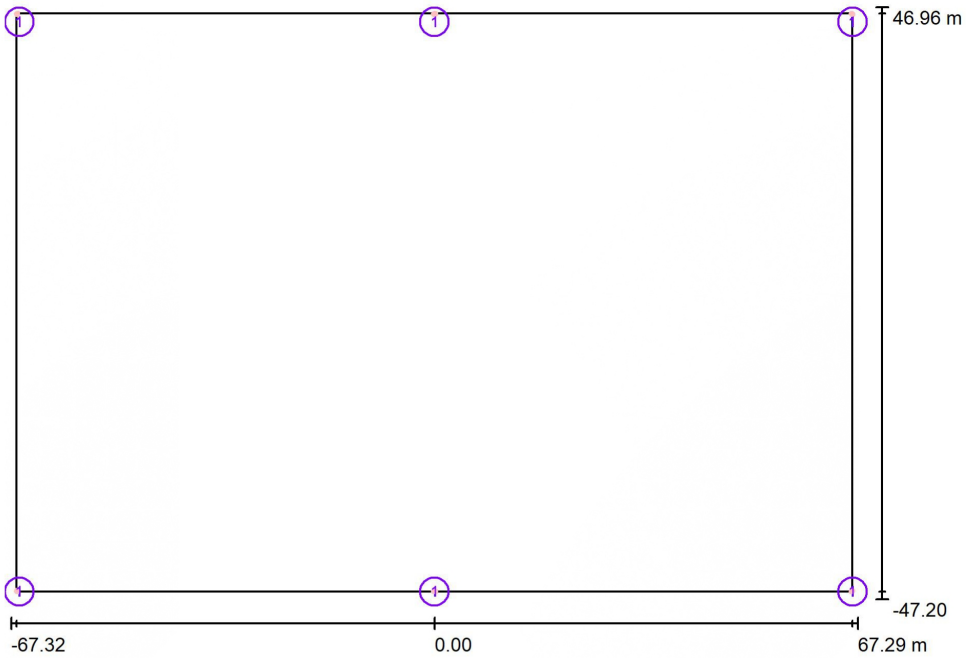
Football Ground / Luminaires (layout plan)



Scale 1 : 963

Luminaire Parts List

No.	Pieces	Designation
1	376	SILVERSUN FLC1000FW FloodLight Round HighMast 25Â° IP65 1000W 5700K

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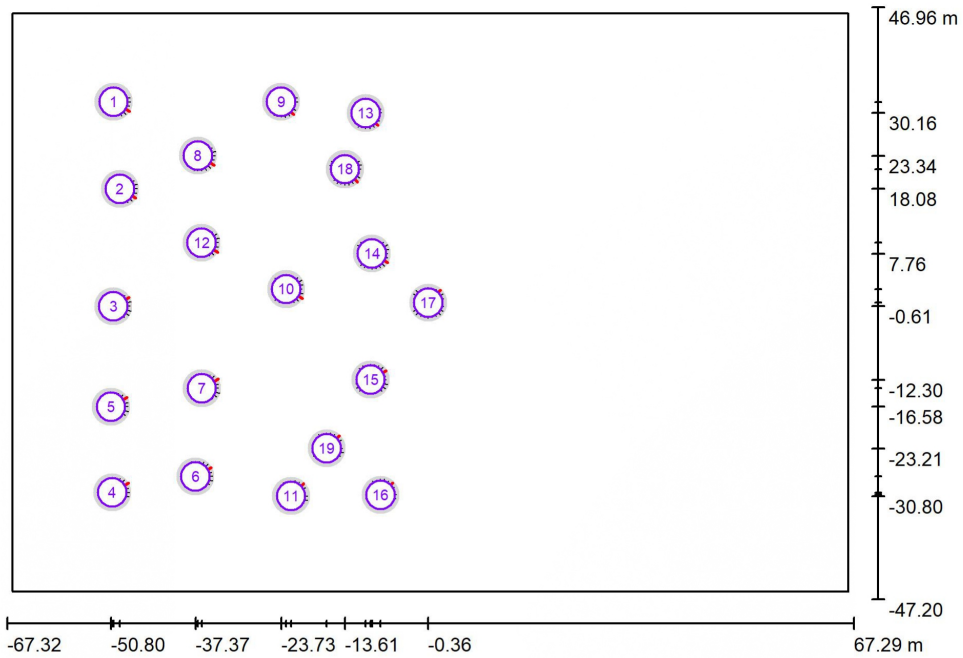
e-Mail

Football Ground / GR Observer (Results Overview)



Scale 1 : 963

GR Observerlist

No.	Designation	Position [m]			Viewing sector [°]				Max
		X	Y	Z	Start	End	Increment	Slope angle	
1	GR Observer 13	-50.400	31.900	1.500	0.0	360.0	15.0	-2.0	40 2)
2	GR Observer 13	-49.400	18.082	1.500	0.0	360.0	15.0	-2.0	41 2)
3	GR Observer 13	-50.415	-0.615	1.500	0.0	360.0	15.0	-2.0	39 2)
4	GR Observer 13	-50.609	-30.217	1.500	0.0	360.0	15.0	-2.0	40 2)

Operator
Telephone
Fax
e-Mail

Football Ground / GR Observer (Results Overview)

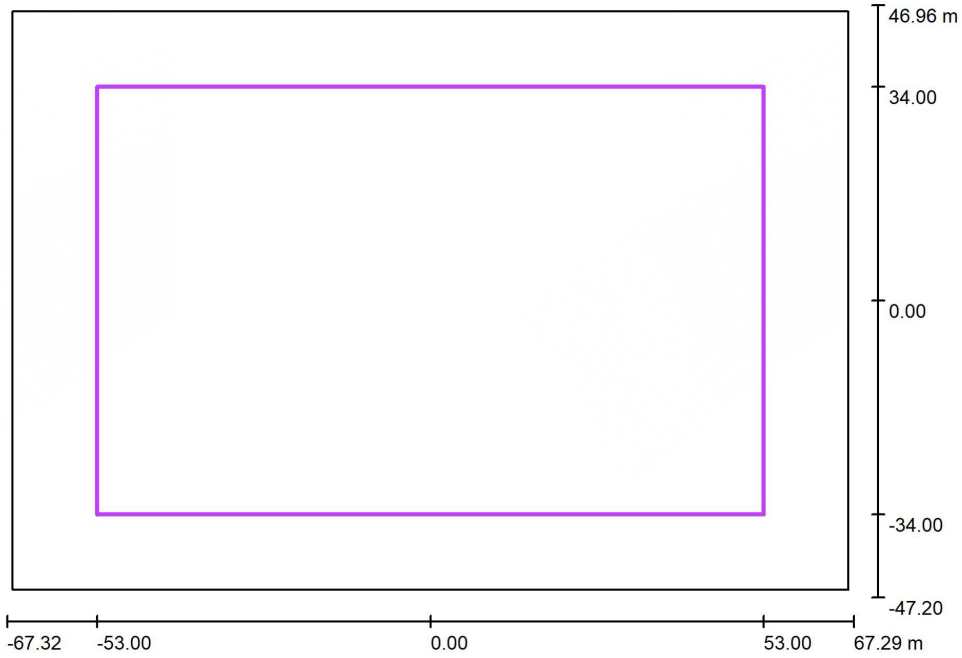
GR Observerlist

No.	Designation	Position [m]			Viewing sector [°]				Max
		X	Y	Z	Start	End	Increment	Slope angle	
5	GR Observer 13	-50.804	-16.584	1.500	0.0	360.0	15.0	-2.0	41 2)
6	GR Observer 13	-37.366	-27.685	1.500	0.0	360.0	15.0	-2.0	39 2)
7	GR Observer 13	-36.366	-13.663	1.500	0.0	360.0	15.0	-2.0	41 2)
8	GR Observer 13	-36.977	23.340	1.500	0.0	360.0	15.0	-2.0	40 2)
9	GR Observer 13	-23.733	31.909	1.500	0.0	360.0	15.0	-2.0	39 2)
10	GR Observer 13	-22.954	2.112	1.500	0.0	360.0	15.0	-2.0	41 2)
11	GR Observer 13	-22.175	-30.801	1.500	0.0	360.0	15.0	-2.0	39 2)
12	GR Observer 13	-36.392	9.513	1.500	0.0	360.0	15.0	-2.0	41 2)
13	GR Observer 13	-10.296	30.156	1.500	0.0	360.0	15.0	-2.0	38 2)
14	GR Observer 13	-9.296	7.760	1.500	0.0	360.0	15.0	-2.0	39 2)
15	GR Observer 13	-9.517	-12.300	1.500	0.0	360.0	15.0	-2.0	39 2)
16	GR Observer 13	-7.958	-30.606	1.500	0.0	360.0	15.0	-2.0	37 2)
17	GR Observer 13	-0.363	-0.030	1.500	0.0	360.0	15.0	-2.0	38 2)
18	GR Observer 13	-13.606	21.198	1.500	0.0	360.0	15.0	-2.0	39 2)
19	GR Observer 13	-16.528	-23.206	1.500	0.0	360.0	15.0	-2.0	39 2)

2) The calculated equivalent veil luminance of the environment is based on the assumption of a complete diffuse reflection behavior of the environment (acc. EN 12464-2).

Operator
Telephone
Fax
e-Mail

Football Ground / Calculation Grid Horizontal / Summary



Scale 1 : 963

Position: (0.000 m, 0.000 m, 0.000 m)
Size: (106.000 m, 68.000 m)
Rotation: (0.0°, 0.0°, 0.0°)
Type: Normal, Grid: 22 x 14 Points

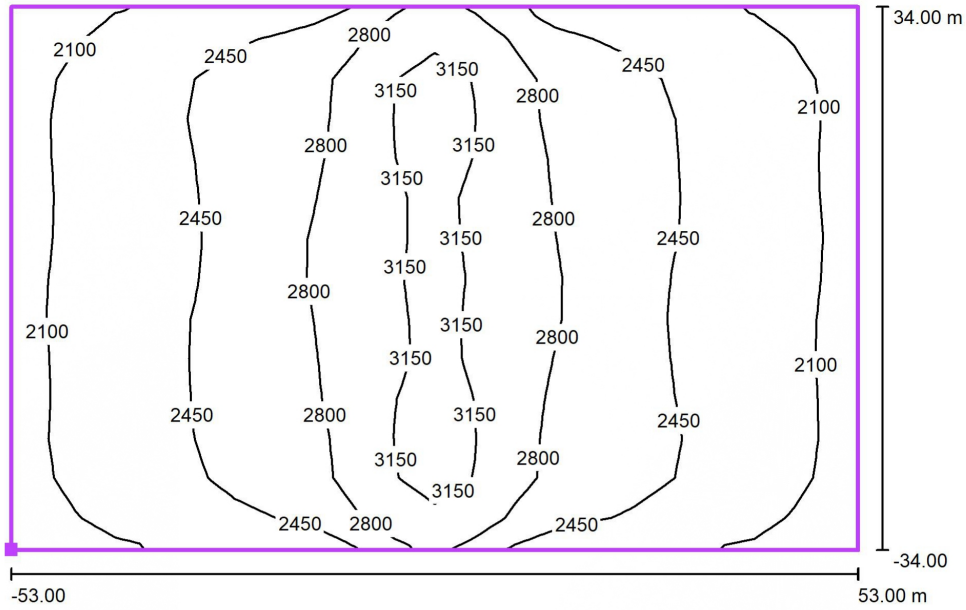
Results overview

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	horizontal	2504	1760	3326	0.70	0.53	/	0.000	/

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

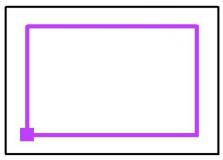
Operator
Telephone
Fax
e-Mail

Football Ground / Calculation Grid Horizontal / Isolines (E, Horizontal)



Values in Lux, Scale 1 : 758

Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)

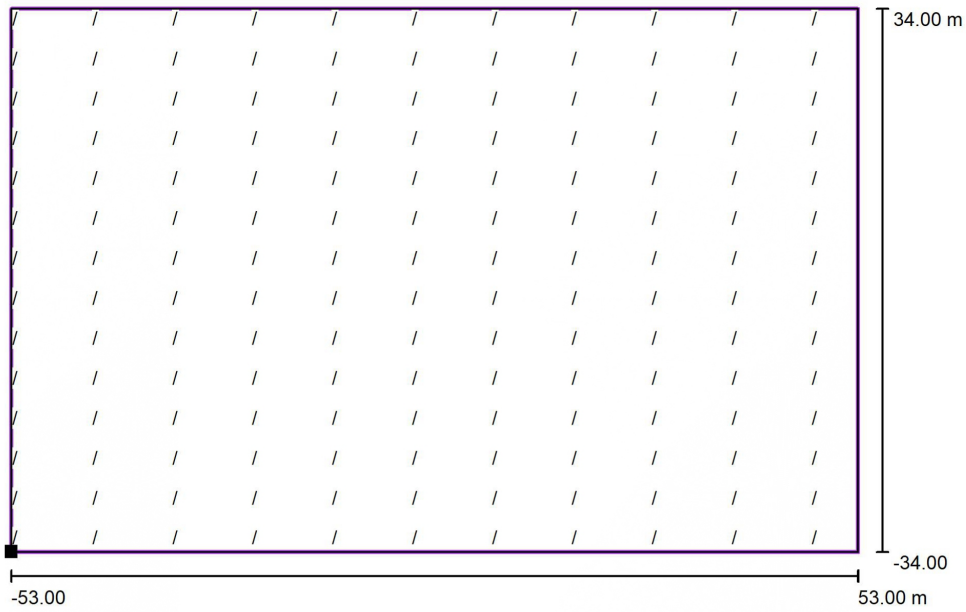


Grid: 22 x 14 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
2504	1760	3326	0.70	0.53

Operator
Telephone
Fax
e-Mail

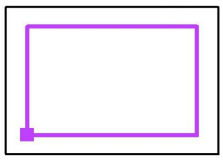
Football Ground / Calculation Grid Horizontal / Gradient Graphics (E, Horizontal)



Values in %, Scale 1 : 758

Not all calculated values could be displayed.

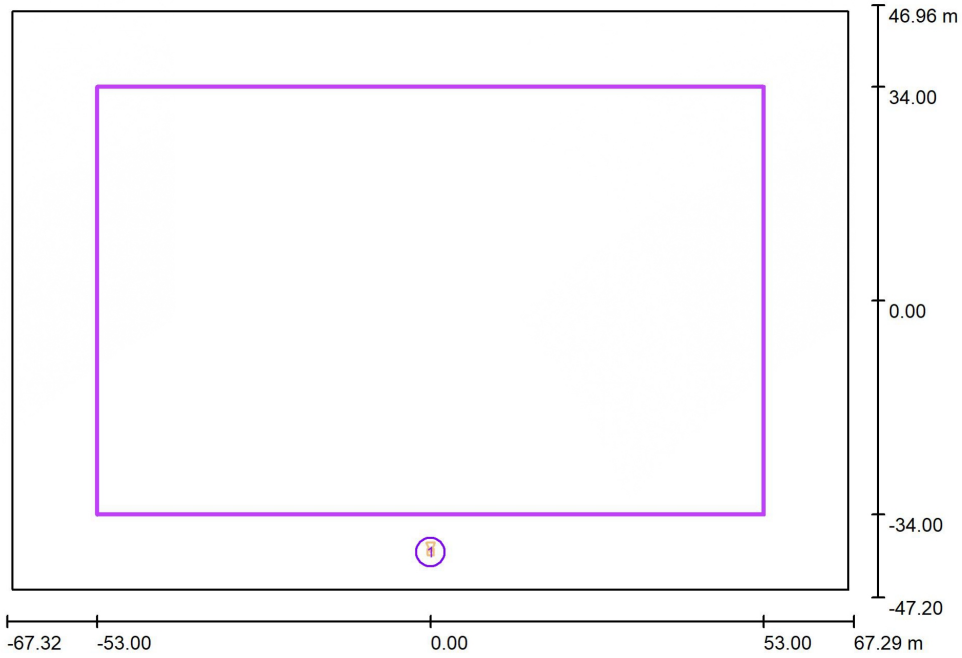
Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)



Maximum Change: 15%
Selected Limit Value: 25% (Values below this limit value are not output.)
Distance for the Gradient Grid: 5.000 m

Operator
Telephone
Fax
e-Mail

Football Ground / Calculation Grid Ecam / Summary



Scale 1 : 963

Position: (0.000 m, 0.000 m, 0.000 m)
Size: (106.000 m, 68.000 m)
Rotation: (0.0°, 0.0°, 0.0°)
Type: Normal, Grid: 22 x 14 Points

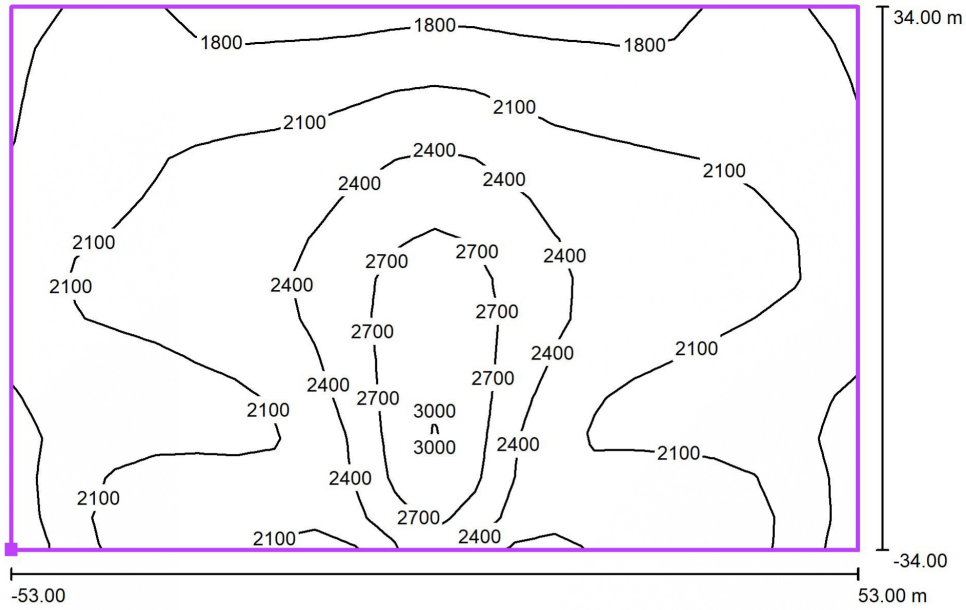
Results overview

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	Camera	2145	1586	3053	0.74	0.52	/	1.000	1

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

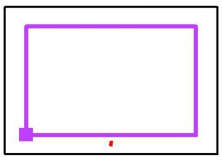
Operator
Telephone
Fax
e-Mail

Football Ground / Calculation Grid Ecam / Isolines (E, Camera)



Values in Lux, Scale 1 : 758

Position of surface in external scene:
Marked point: (-53.000 m, -34.000 m, 0.000 m)
Camera Position: (0.000 m, -40.000 m, 10.000 m)



Grid: 22 x 14 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
2145	1586	3053	0.74	0.52

8.3 Comparison of lighting data obtained from 4 and 6 pole arrangement :

Sl. No.	Description	Target Parameter(As per FIFA2020)	4 Pole Arrangement	6 Pole Arrangement
1. Installation Parameter :				
1.a	Height of High Mast (M)		36.40	30.40
1.b	Number of High Mast		4	6
1.c	Number of Luminaires		392	376
2. Lighting Design Parameter :				
2.a	**Horizontal Illuminance :**			
i.	Average (Ehavg) (Lux)	>= 2500	2627	2504
ii.	Uniformity, U1	>= 0.57	0.58	0.53
iii.	Uniformity, U2	>= 0.70	0.70	0.70
iv.	Gradient Graphics	=<25%	Max. 18%	Max. 15%
2.b	**Camera Vertical Illuminance :**			
i.	Average (Ehavg) (Lux)	>= 1500	1855	2145
ii.	Uniformity, U1	>= 0.50	0.48	0.52
iii.	Uniformity, U2	>= 0.70	0.60	0.74
3.	Glare Rating	<50	Max 41 .	Max. 41
4.	$Eh_{avg}/\ Ev_{avg}$	0.5 - 2.0	1.41	1.16

Table 8.1: Comparison of lighting data obtained from 4 and 6 pole arrangement

From the above table it is seen that both types of arrangement satisfy the desired lighting level. But still there is little difference two types pole arrangement, those are –

1. Lighting quality in respect of the illuminance gradient and camera vertical are better with 6 pole arrangement than 4 pole arrangement.

2. Using less amount of luminaires in 6 pole arrangement compared to 4 pole arrangement, target lighting parameters values are achived.

Chapter 9

Electrical equipments and accessories for sports facility

9.1 Switch Gear :

Switch gear is an apparatus used for switching, controlling and protecting the electrical equipments , circuits and devices. It includes different circuit breaker, isolators, protective relays, lightning arresters, measuring instruments etc. In electrical installaton of sports facilities low voltage (rated upto 1kV) and medium voltage indoor switch gear (rated upto 33kV) equipments are used.

9.2 Transformer :

In stadium lighting indoor type distribution power transformers are used. The size and number of the transformer depends on the requirement of power needed for lighting and other loads of stadium.

9.3 DG Set :

To ensure the reliability of power supply during a match or practice session, it is essential to have a secondary power source for the stadium lighting. Therefore, one or more DG sets with control panels of suitable capacity are required to be installed in associate with the licensed electrical power supply.

9.4 Cables :

Cables of different size and capacities are required to be drawn for feeding supply
i. from HT gear room to transformer
ii. Transformer to LT distribution panel
iii. LT distribution panel to control room
iv. Control room to flood light on high masts.
Apart from these control cables are used for actuating the contractors, relay and for AMF panels of DG set.

9.5 Sports Luminaire :

Sports luminaires are mounted on high masts. LED lumianires having IP65 and IK10 rating protection level are used as sports lights.

9.6 High Mast :

High mast facilitates to illuminate a large area. In stadium lighting high masts with fixed type head frame are commonly used. It is fabricated from steel plates conforming to BSEN 10025, GR-S25510 or equivalent.

The entire mast and mild steel plates are to be hot dip galvanised to protect it from corrosion & erosion conforming to BSEN ISO 1461 or equivalent. The high mast is continuous tapered and polygonal in cross section. At the base of the high mast, there is a door of adequate opening size to allow access of equipments like winch, ropes, cables etc. Mast structure is designed to withstand 'Gust wind speed' as per IS875 (Part 3) 1987 and is measured at a height of 10m above the ground level.[18]

For accessing luminaires on the head frame, a platform with adequate ladders having safety ring are to be provided. On the top of the high mast aviation obstruction luminaire and 2 nos. lighting arrestors are mounted.

9.7 Aviation Obstruction Light :

All high masts in the football court should be accompanied with aviation obstruction light for safe navigation of aircraft. Ac powered and battery backed up high intensity red LED luminaire is used as aviation obstruction light. It provides a viewing range of more than 6 km. It may be two types, flash type or constantly illuminated type and operates on either by manually or by using a photo sensor. The ingress protection of this luminaire is IP66.[8]

9.8 Earthing Equipments :

For the safety of human beings as well as to protect the electrical installation, earthing is necessary. HT gear room, transformers, DG sets, LT distribution panel, control room, high mast & lightnign arrestors are to be earthed in seperate earth pits. All the earth pits are connected to each other by ringmain system. GI pipe earthing is used for all pits. 80mm dia and 3.3m long GI pipe with all other necessary accessories are employed for earthing.

9.9 Lightning Arrester :

A lightning arrester is a device that safely bypass the voltage surges caused by the lightning strikes and thus protect structures, power lines, electrical and electronic devices. In a football stadium each high mast contains 2 nos. lightning arresters with proper earthing accessories for the protection of the building as well electrical and electronics equipments.

Chapter 10

Design of electrical installations for 4 pole arrangement

10.1 Plan of the football arena depicting Gear room, Distribution room, Control rooms and high masts location (4 pole arrangement)

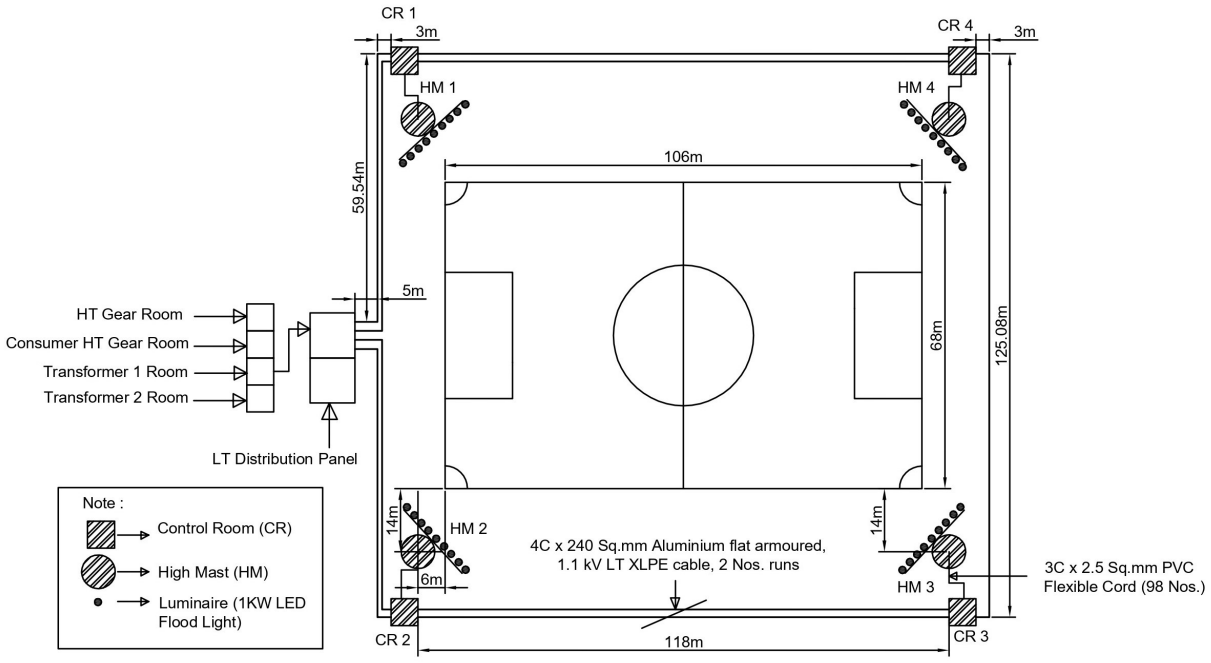
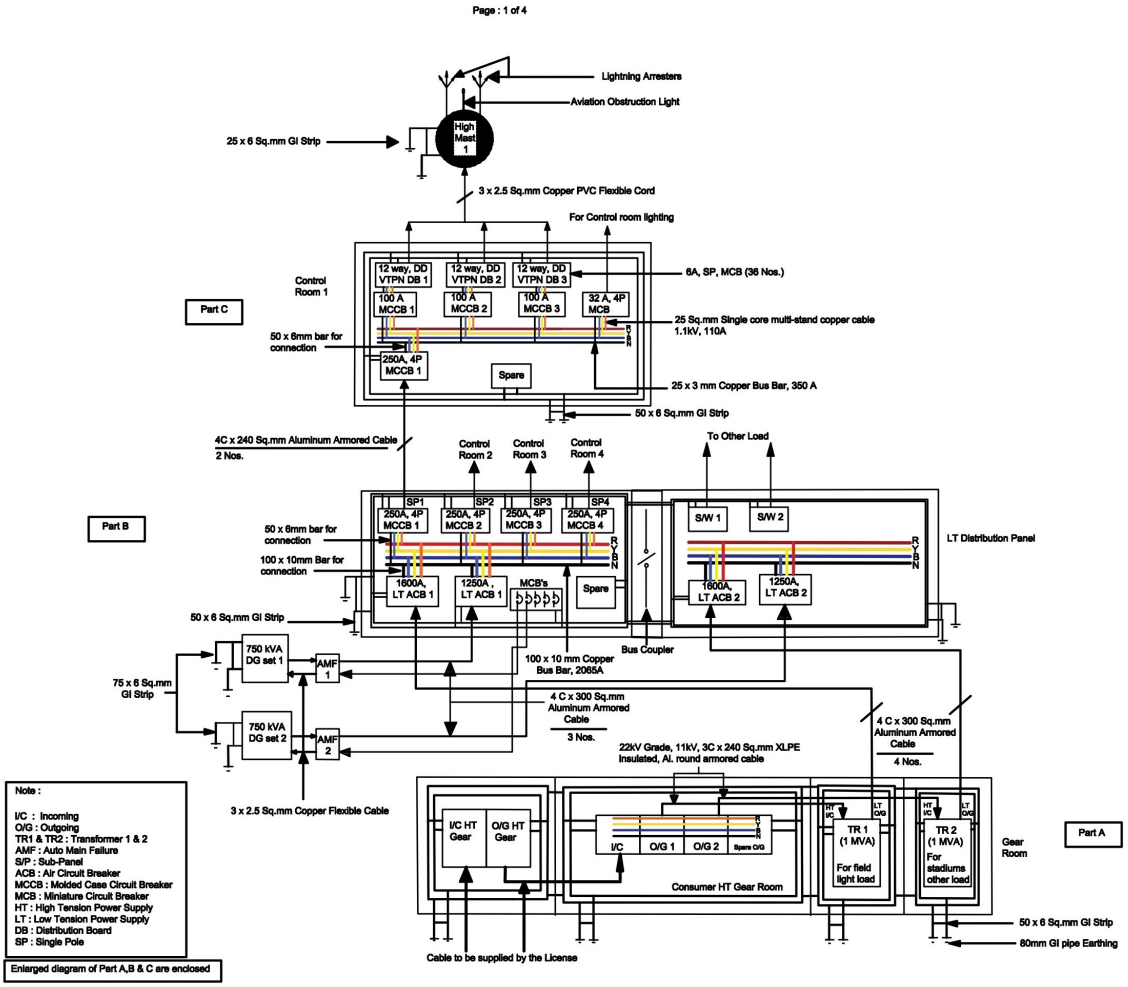


Figure 10.1: Plan of the football arena (4 Pole)

10.2 Layout diagram of entire electrical installation :

Detailed layout diagram of the entire electrical installation comprising licensed HT gear room, DG sets, LT distribution panel room, control room, high mast, cables etc. is shown in the following diagram :

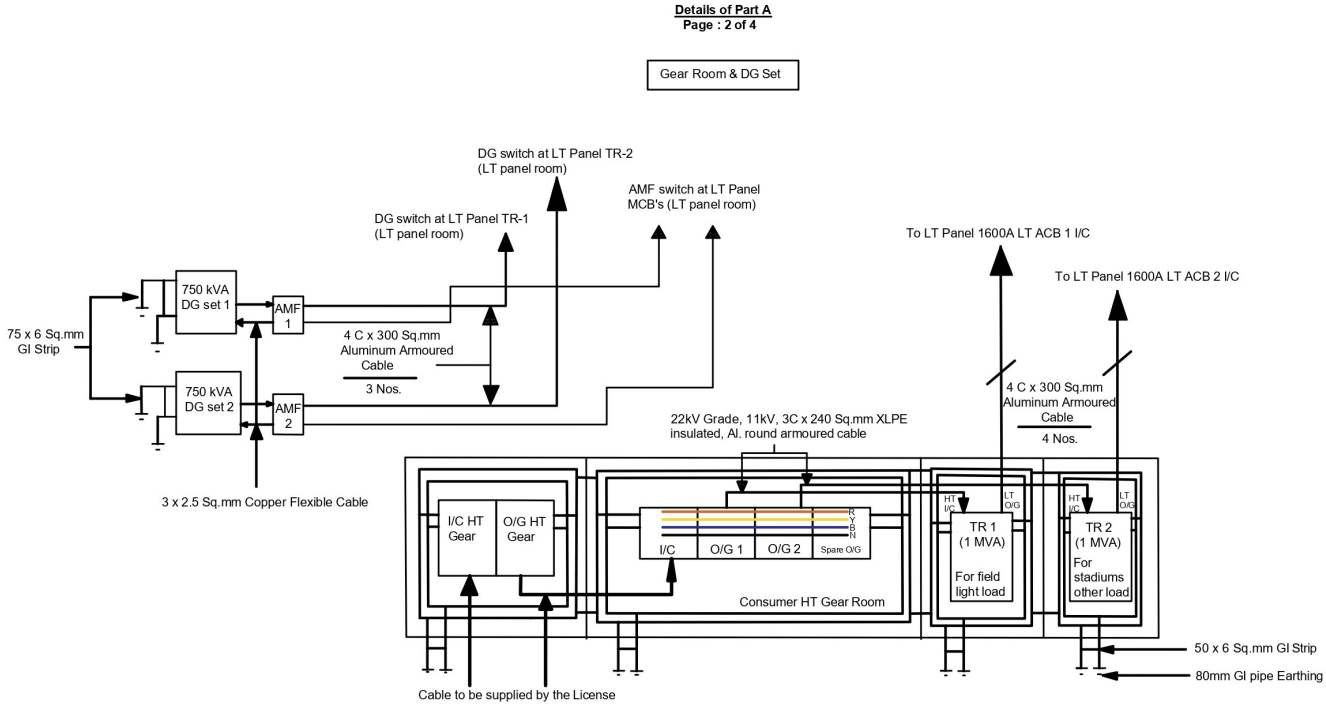


The electrical installation is divided into 3 parts —
Part A : HT Gear & DG set
Part b : LT distribution panel
Part C : Control room & High mast

The size and rating of electrical equipments used in the above parts are evaluated separately in the following sections.

10.3 Layout diagram of HT gear room and DG set (Part - A)

Layout diagram of HT gear room & DG sets are shown below.



For 4 pole arrangement load current required for each high mast luminaires are —

No. of luminaires = 98
Power of each luminaire = 1 kW
Power required for each mast = 98 kW = 98000 W

$$P = \sqrt{3}\ V_L\ I_L\ Cos\phi$$

$$taken,\ cos\phi = 0.8$$

$$V_L = 415\ volt$$

$$So,\ 9800\ = \sqrt{3} \times 415 \times I_L \times 0.8$$

$$I_L\ = \frac{98000}{\sqrt{3} \times 415 \times 0.8}\ =\ 170.42 \approx 171\ A$$

Therefore, total current required for 4 masts = 171 x 4 = 684 A ≈ 700A.
Considering other load required for the stadium = 300A (approx)
So, total load requirement = 700 + 300 = 1000 A.

10.3.1 Evaluation of transformer rating :

For 3 phase transformer –

$$VA = \sqrt{3} \times V \times I$$

$$= 1.732 \times 415 \times 1000$$

$$= 718780 \approx 100000\ VA = 1MVA$$

Therefore, 1MVA, 3 ϕ, 11kV/415V, dry type indoor Δ / Y distribution transformer is suitable to take care of entire installation load. But we have considered 2 nos. 1 MVA distribution transforemers.
In normal condition transformer 1 will take care of the field lighting load and transformer 2 will supply other load required at the stadium.
In case of failure of one transformer the other one can be employed to supply total load required by the electrical installation.

10.3.2 Evaluation of cable size and ratings :

Cable cross section , A = I_{sc} x $(\sqrt{t}/K)$mm^2
I_{sc} = Short circuit current in kA
t = time of fault = 1 sec (take)
k = constant = 0.094 for AL,XLPE cable or 0.144 for CU, XLPE cable.

Short circuit current,

$$I_{sc} = \frac{I_{secondary}}{\%Impedence}$$

[% impedance = 0.05]

$$= \frac{1000}{0.05}$$

$$= 20,000A = 20\ kA$$

$$A = \frac{20 \times \sqrt{1}}{0.094}\ Sq.mm$$

$$= 212.76 \approx 213 Sq.mm$$

Therefore we have considered 12.7/22 kV, 3 Core, Aluminium, XLPE insulated, armoured cable having cross sectional are 240 Sq.mm, which has short circuit current rating 22.56 kA for 1 second duration.
This cable is used to connect HT gear switches with transformers.

10.3.3 Selection of HT switch gear rating :

Due to the very good making, breaking capacity and arc extinguishing properties compared to other types HT circuit breakers, Vacuum circuit breaker rating 11kV with all standard accessories are selected in license HT gear room and consumer HT gear room to feed supply to 1MVA transformer. 11kV/415V VCBs' are connected to distribution transformers by **12.7/22kV, 3C x 240 Sq.mm Aluminium XLPE armoured cable.**
11kV , heat shinkable , 3C x 240 Sq.mm indoor end terminators are used for fixing the cables in the swtich gears housing.

10.3.4 Evaluation of Diesel Generator Set capacity

Provision of DG sets are kept in a sports facility to ensure uninterrupted power supply in case of license power failure. Based upon the load requirement of the stadium, DG set capacity is evaluated.

- **Evaluation of DG set rating :**

Total no. of luminaires on high masts = 392
kW/Luminaire = 1
Power consumed by luminaires = 392 kW
Considered other electrical load of the stadium = 181 kW
So, total power = 392 + 181 = 573 kW

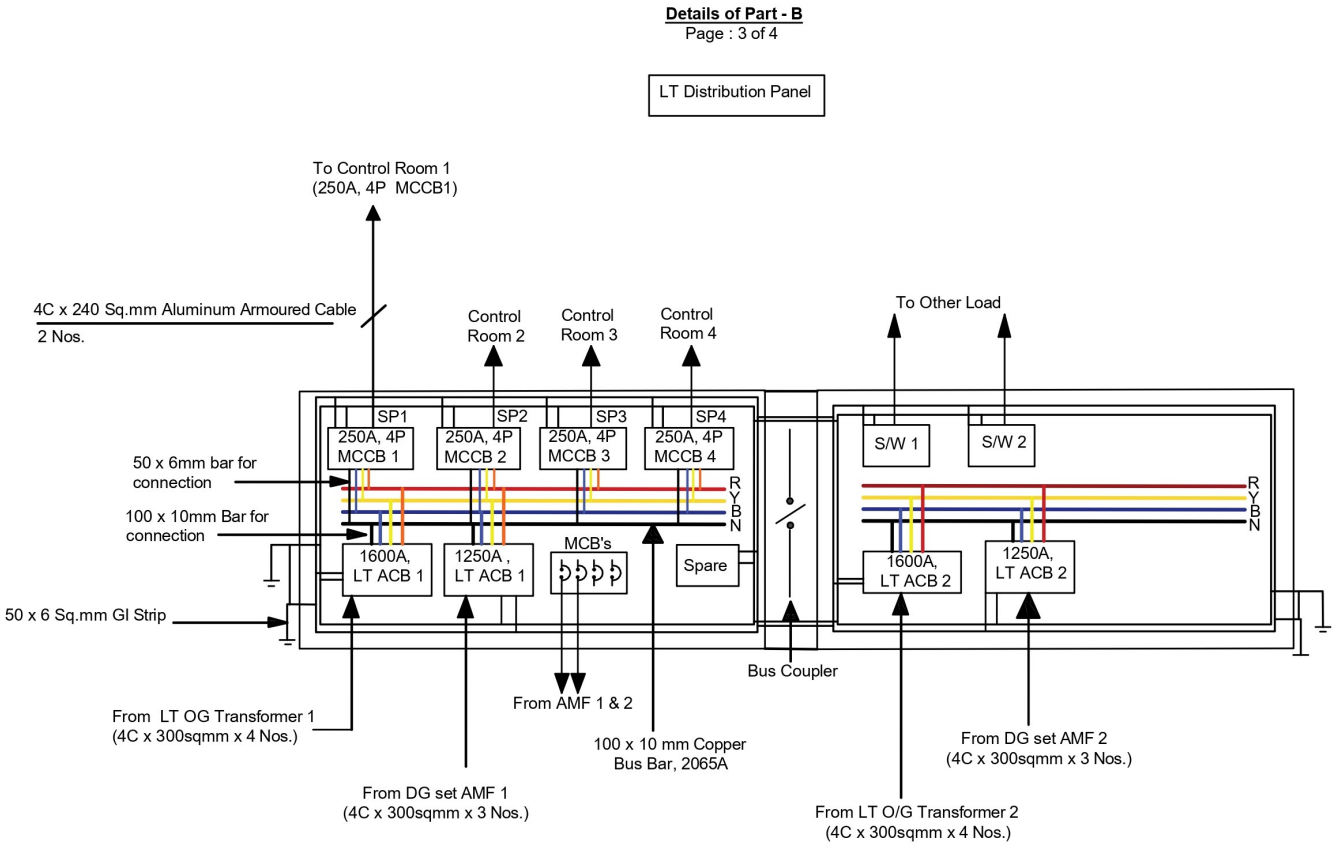
$$kVA\ of\ DG\ Set = \frac{573}{p.f}$$
$$= \frac{573}{0.8} = 716\ kVA$$

We chose 2 nos., 750 kVA DG Set with AMF panel.
The reason of considering 2 nos. DG set is to keep one as stand by and will be employed in case of failure of other one.

DG sets are connected to 1250A LT air circuit breaker in LT distribution panel through **3 nos., 4C x 300 Sq.mm Aluminium armoured, 1.1 kV grade XLPE cable.**

10.4 Layout diagram of LT distribution panel (Part - B)

The LT distribution panel consists of ACBs, MCCBs, Bus coupler, Busbar & MCBs. It acts as a bridge between HT gear room and control rooms located at different part of the stadium.



Each control room is associated with 1 no. high mast and power supply required for high mast and control room itself is fed from distribution panel.
Power requirement for each mast = 98 kW = 98000 W
So, current

$$I_L = \frac{P}{\sqrt{3} \times V_L \times Cos\phi}$$

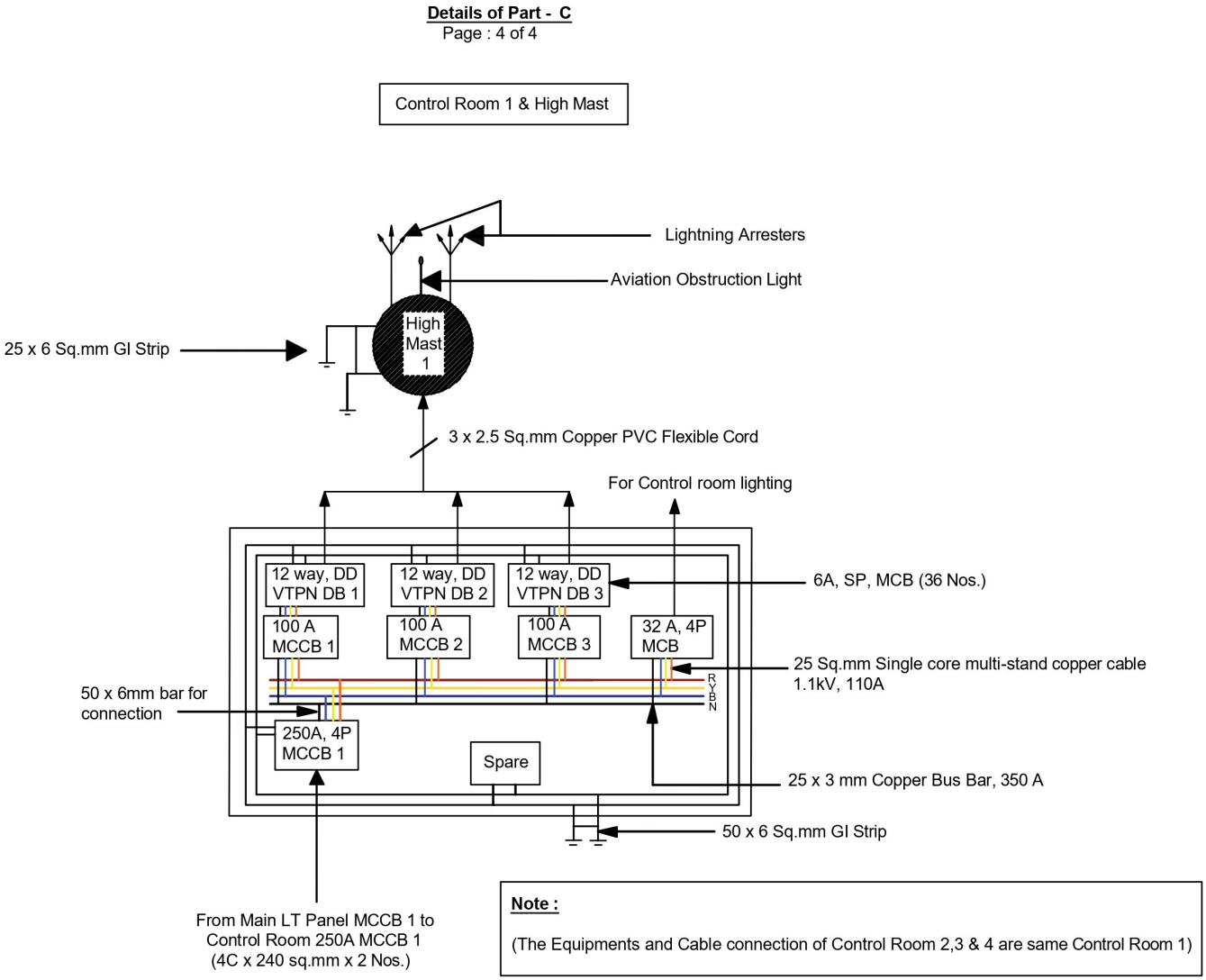
$$= \frac{98000}{\sqrt{3} \times 415 \times 0.8} \;=\; 170.42 \approx 171 \; A$$

Considering factor of safety and additional load for control room itself, **250 A, 4 Pole MCCB is selected.**

To feed supply to 4 nos. 250 A MCCB and 1 spare 250 A MCCB, ACB of 1600 A capacity is chosen.
On the distribution panel 2 nos. ACBs are installed. In normal condition 1 ACB is dedicated for field load and other one for other load. But in case of failure of one ACB other one can take care of the entire load required by control rooms. 2 nos. ACB of 1250 A capacity mounted on the distribution panel for DG set. 2 nos. multi-function digital meter are fixed on the panel to measure the different electrical quantities.

10.5 Layout diagram of a control room (Part - C)

The layout diagram of control room is shown below.



The control panel consists of **250A, 4 Pole MCCB, 100A 4 Pole MCCBs, 32A 4 Pole MCB, 12 way double door VTPN DBs, 6A SP MCBs and multi-function digital meter.**

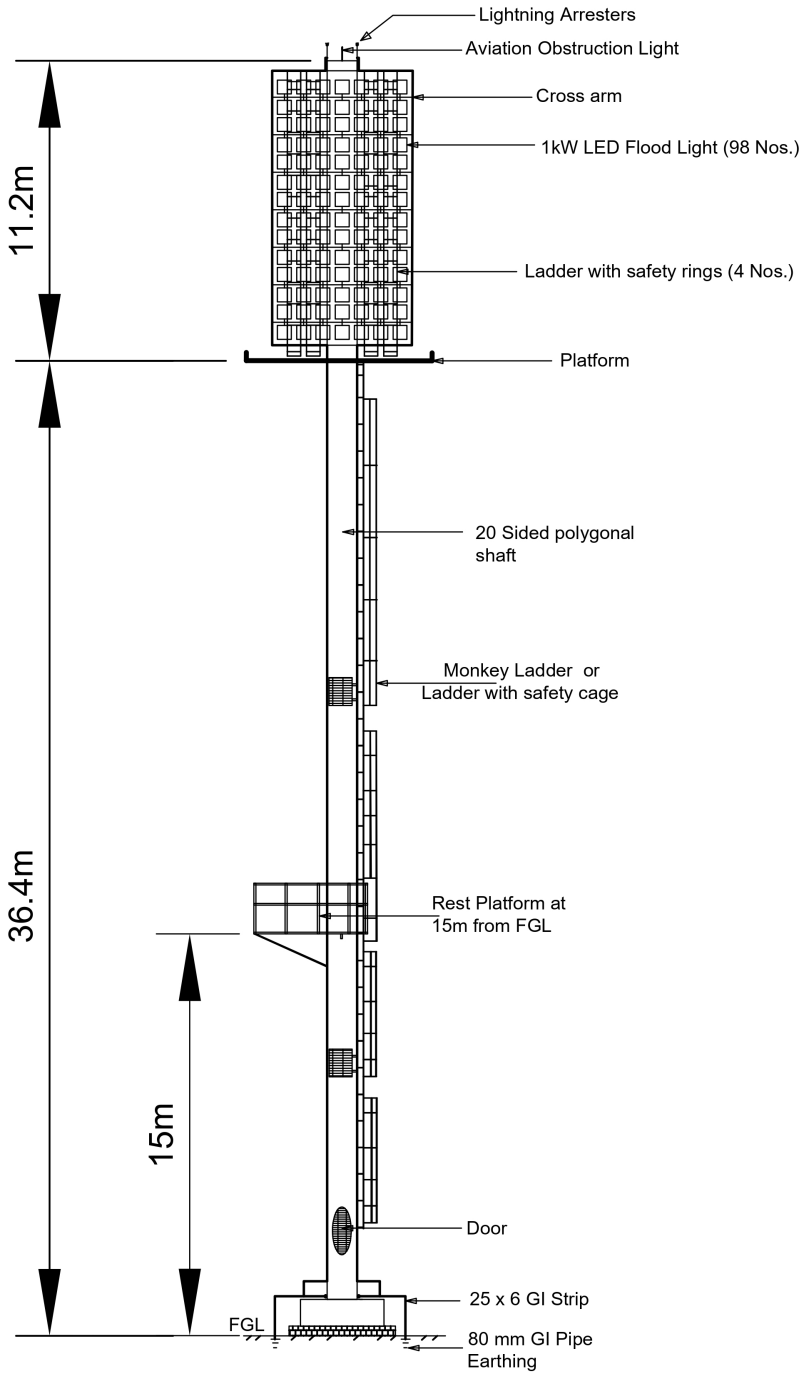
The supply fed to 250A, 4P MCCB by LT distribution panel. Each flood light on the head frame of the mast is connected to 12 way DB by 3 x 2.5 Sq.mm Copper flexible cord. Flexible cord are run through a GI cable tray. Current required by each luminaire –

$$I_{lum} = \frac{1kW}{230V} = \frac{1000}{230} = 4.35A$$

So, 6A MCB for each luminaire is sufficient. 1 no. 12 way DD VTPN DB can accommodate 18 x 2 = 36 nos. 6A MCB. Therefore, to accommodate 98 MCBs, 3 nos. 12 way DD VTPN DB are sufficient.

10.6 Design of High Mast

The diagram of the high mast along with head frame & accessories is appended below.



Dimensions & data relating to the high mast :

- Height of the mast = 36.40m
- No. of side of the mast structure = 20
- Head frame height = 11.2m
- Head frame width = 5.24m
- No. of cross arm = 7
- No. of ladder on top platform = 4

The mast is associated with ladder sand safety cage to access to the top platform. One rest platform is provided at a height of 15m from the base. Safety cage is suspended by steel wire ropes and can be driven either manually or by power.

A lockable door provided at the bottom of the mast to permit equipments such as cage, ropes, cables etc. Each mast contains 2 nos. lightning arrester of 1m height and one no. avaiation obstruction luminaire.

Chapter 11

Design of electrical installations for 6 pole arrangement

11.1 Plan of the football arena depicting Gear room, Distribution room, Control rooms and high masts location (6 pole arrangement)

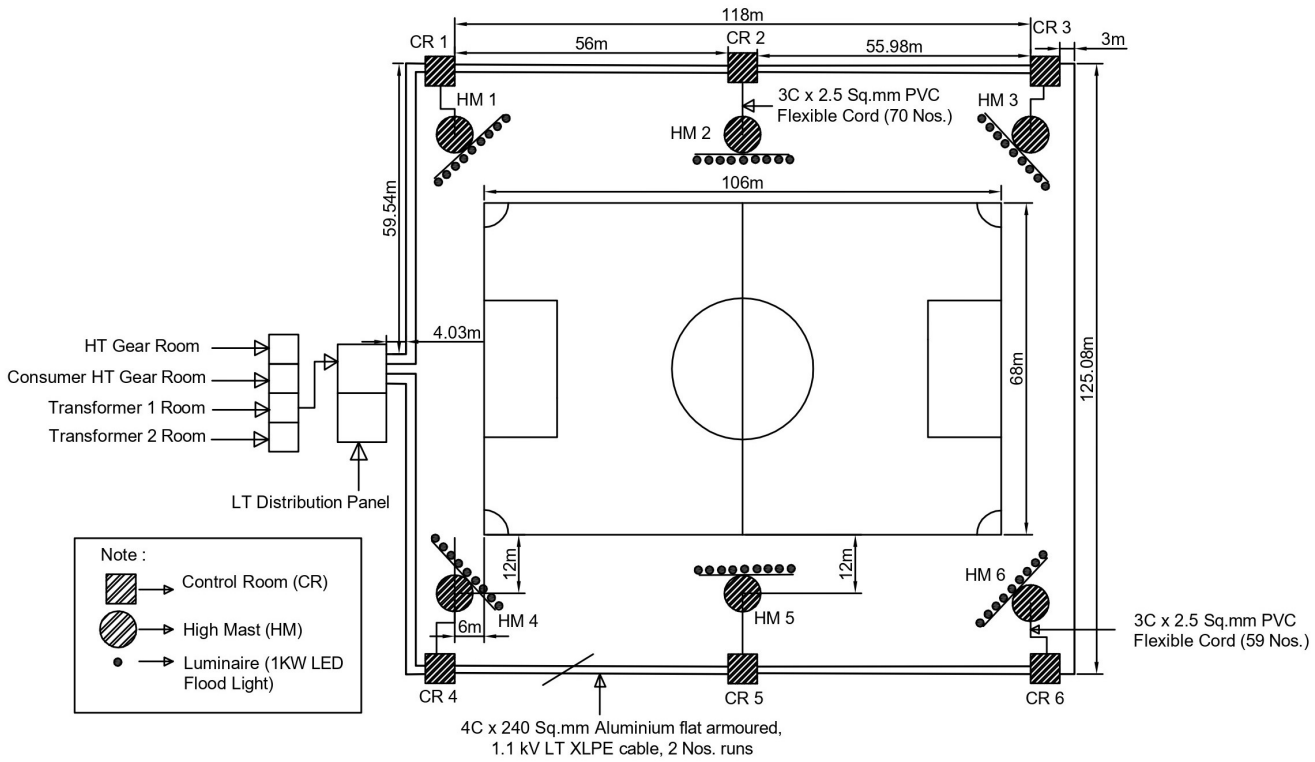
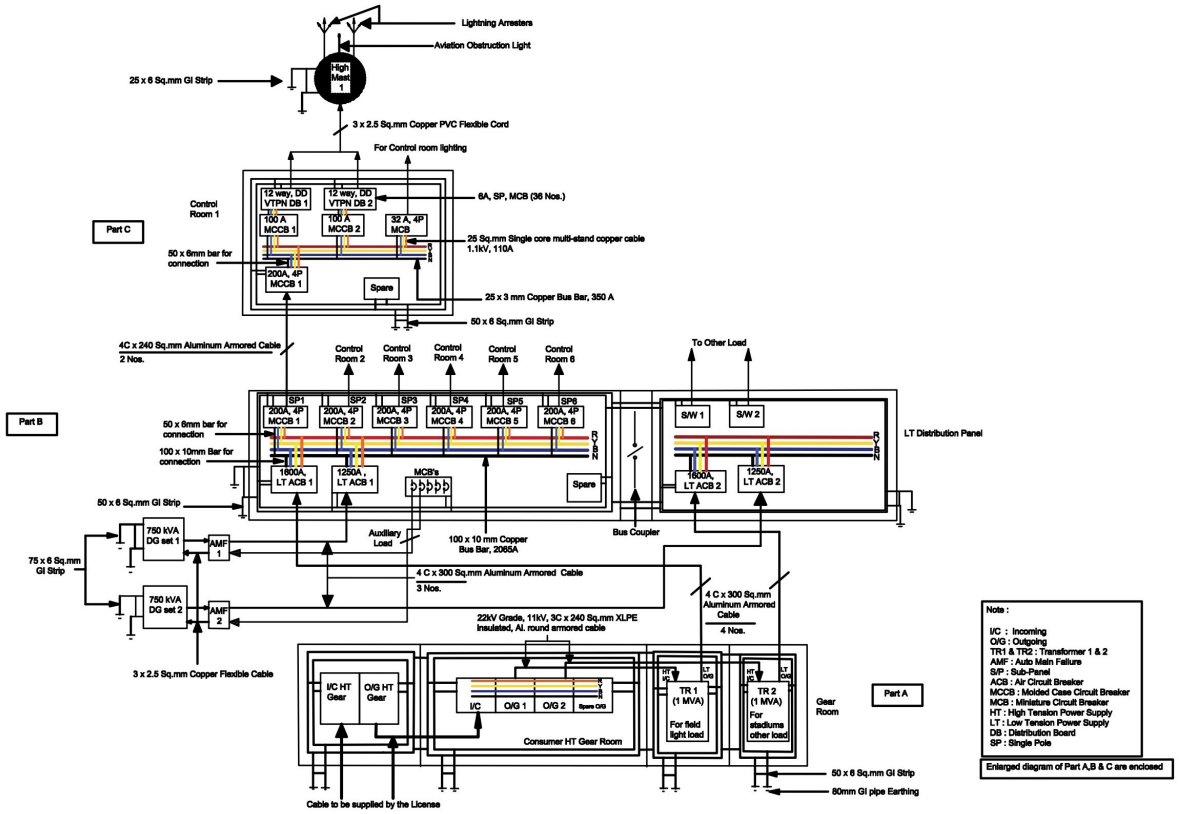


Figure 11.1: Plan of the football arena (6 Pole)

11.2 Layout diagram of entire electrical installation :

Detailed layout diagram of the entire electrical installation comprising licensed HT gear room, DG sets, LT distribution panel room, control room, high mast, cables etc. is shown in the following diagram :

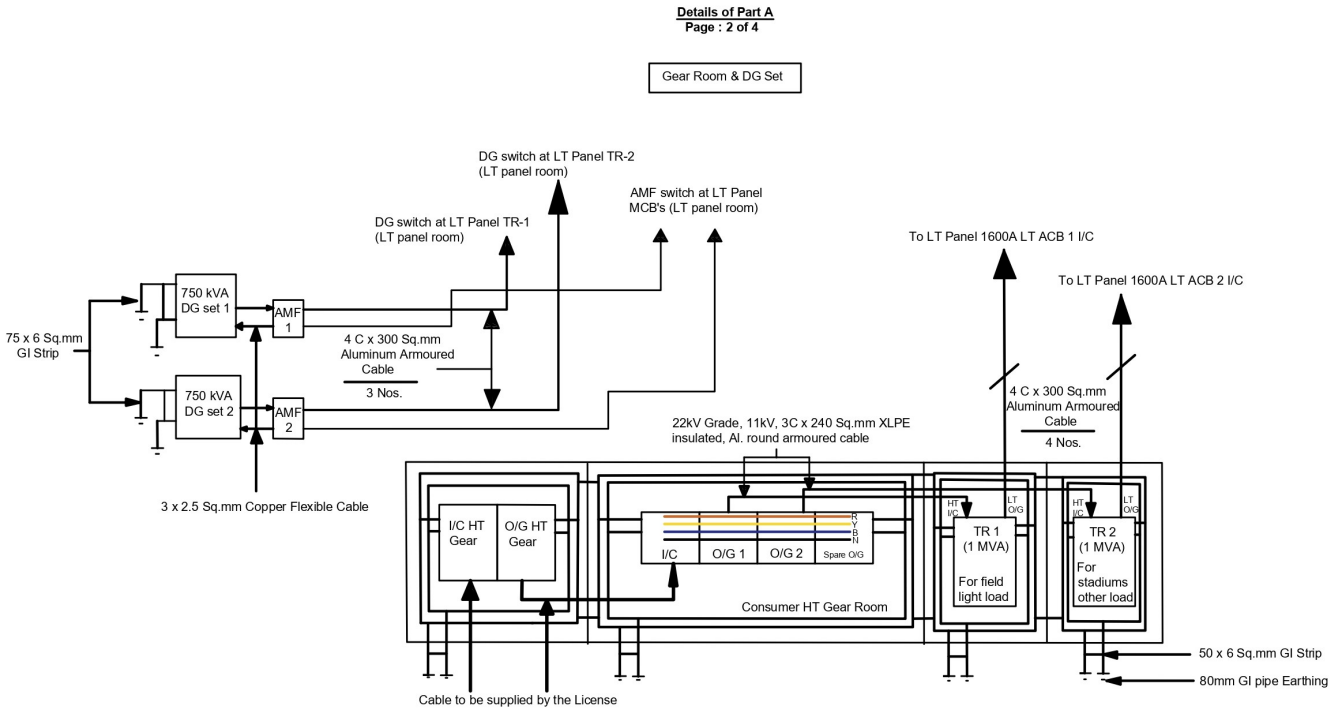


The electrical installation is divided into 3 parts —
Part A : HT Gear & DG set
Part b : LT distribution panel
Part C : Control room & High mast

The size and rating of electrical equipments used in the above parts are evaluated separately in the following sections.

11.3 Layout diagram of HT gear room and DG set (Part - A)

Layout diagram of HT gear room & DG sets are shown below.



- **Corner Mast :**

No. of luminaires of each mast = 59
Power of each luminaire = 1 kW
Power required for each mast = 59 kW = 59000 W

$$P = \sqrt{3} V_L I_L Cos\phi$$
$$taken, cos\phi = 0.8$$
$$V_L = 415\ volt$$

$$So, 59000 = \sqrt{3} \times 415 \times I_L \times 0.8$$
$$I_{L1} = \frac{59000}{\sqrt{3} \times 415 \times 0.8} \ = \ 102.60 \approx 103\ A$$

Therefore, total current required for 4 masts = 103 x 4 = 412 A

- **Side Mast :**

No. of luminaires for each mast = 70
Power of each luminaire = 1 kW
Power required for each mast = 70 kW = 70000 W

$$I_{L1} = \frac{70000}{\sqrt{3} \times 415 \times 0.8} == 121.7 \approx 122\ A$$

For 2 nos. side mast, consumer required = 122 x 2 = 244 A.
So, total load current for the field = 412 + 244 = 656 A.
Considering other load requirement = 344 A.
Total current requirement = 656 + 344 = 1000 A.

11.3.1 Evaluation of transformer rating :

For 3 phase transformer –

$$VA = \sqrt{3} \times V \times I$$
$$= 1.732 \times 415 \times 1000$$
$$= 718780 \approx 100000VA = 1MVA$$

Therefore, 1MVA, 3 ϕ, 11kV/415V, dry type indoor Δ / Y distribution transformer is suitable for entire installation load.However, 2 nos. transformers are used for supplying field load and other loads separately. In case of failure of any one, the other one can efficiently handle the total load required by the installation.

11.3.2 Evaluation of cable size and ratings :

Cable cross section , A = I_{sc} x $(\sqrt{t}/K)$mm^2
I_{sc} = Short circuit current in kA
t = time of fault = 1 sec (take)
k = constant = 0.094 for AL,XLPE cable or 0.144 for CU, XLPE cable.

Short circuit current,

$$I_{sc} = \frac{I_{secondary}}{\%Impedence}$$

[% impedance = 0.05]

$$= \frac{1000}{0.05}$$
$$= 20,000\ A\ =\ 20\ kA$$

$$A = \frac{20 \times \sqrt{1}}{0.094}\ Sq.mm\ =\ 212.76 \approx 213\ Sq.mm$$

Therefore we have considered 12.7/22 kV, 3 Core, Aluminium, XLPE insulated, armoured cable having cross sectional are 240 Sq.mm, which has short circuit current rating 22.56 kA for 1 second duration.
This cable is used to connect HT gear switches with transformers.

11.3.3 Selection of HT switch gear rating :

Vacuum circuit breaker of capacity 11kV with all standard accessories are selected for license HT gear room and consumer HT gear room. VCBs' are connected to distribution transformers by **12.7/22kV, 3C x 240 Sq.mm Aluminium XLPE armoured cable.**
11kV , heat shinkable , 3C x 240 Sq.mm indoor end terminators are used for fixing the cables in the swtich gears housing.

11.3.4 Evaluation of Diesel Generator Set capacity

Provision of DG sets are kept in a sports facility to ensure uninterrupted power supply in case of license power failure. Based upon the load requirement of the stadium, DG set capacity is evaluated.

- **Evaluation of DG set rating :**

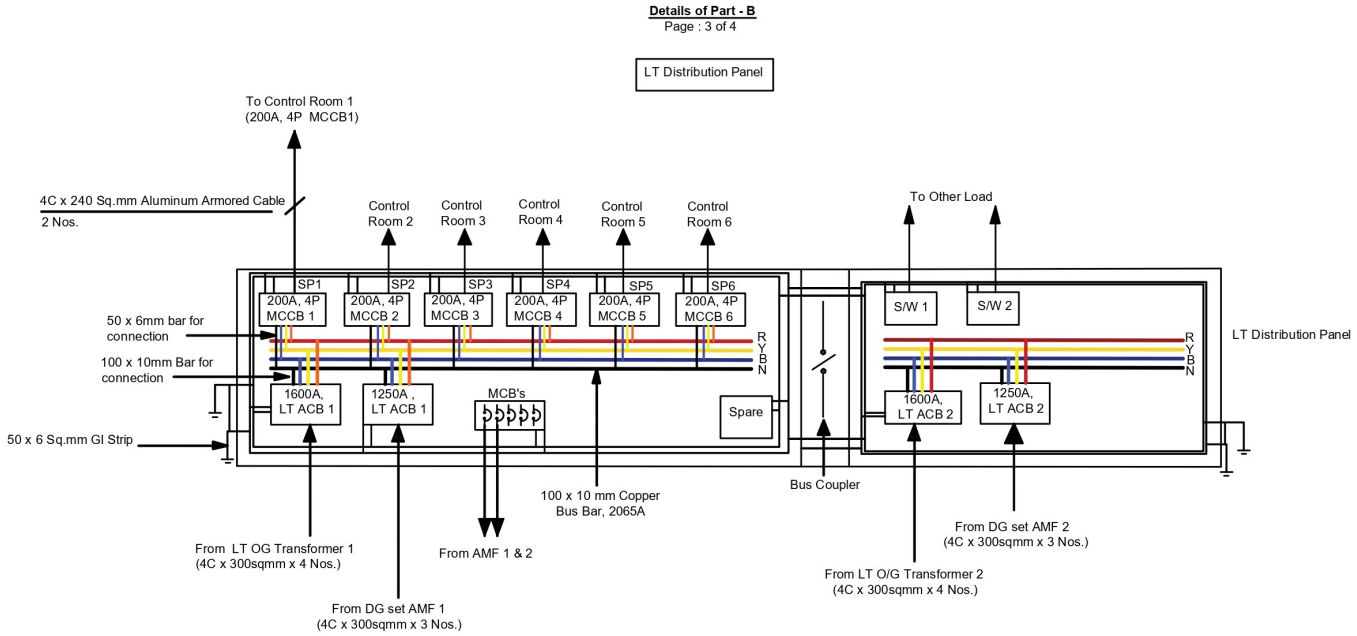
Power consumed by luminaires on the field = 376 kW
Considered other electrical load of the stadium = 197 kW
So, total power = 376 + 197 = 573 kW

$$kVA\ of\ DG\ Set = \frac{573}{p.f}$$
$$= \frac{573}{0.8} \ = \ 716\ kVA$$

So, 1 no. 750 kVA DG set is sufficient to supply the required load. But we considered 2 nos. DG sets to keep one as a stand by and will be operated in case of failure of other one.

11.4 Layout diagram of LT distribution panel (Part - B)

Diagram of LT distribution panel is shown below.



Each control room is associated with 1 no. high mast and power supply required for high mast and control room itself is fed from distribution panel.

Power requirement for each side mast = 70 kW = 70000 W
So, current

$$I_L = \frac{P}{\sqrt{3} \times V_L \times Cos\phi}$$

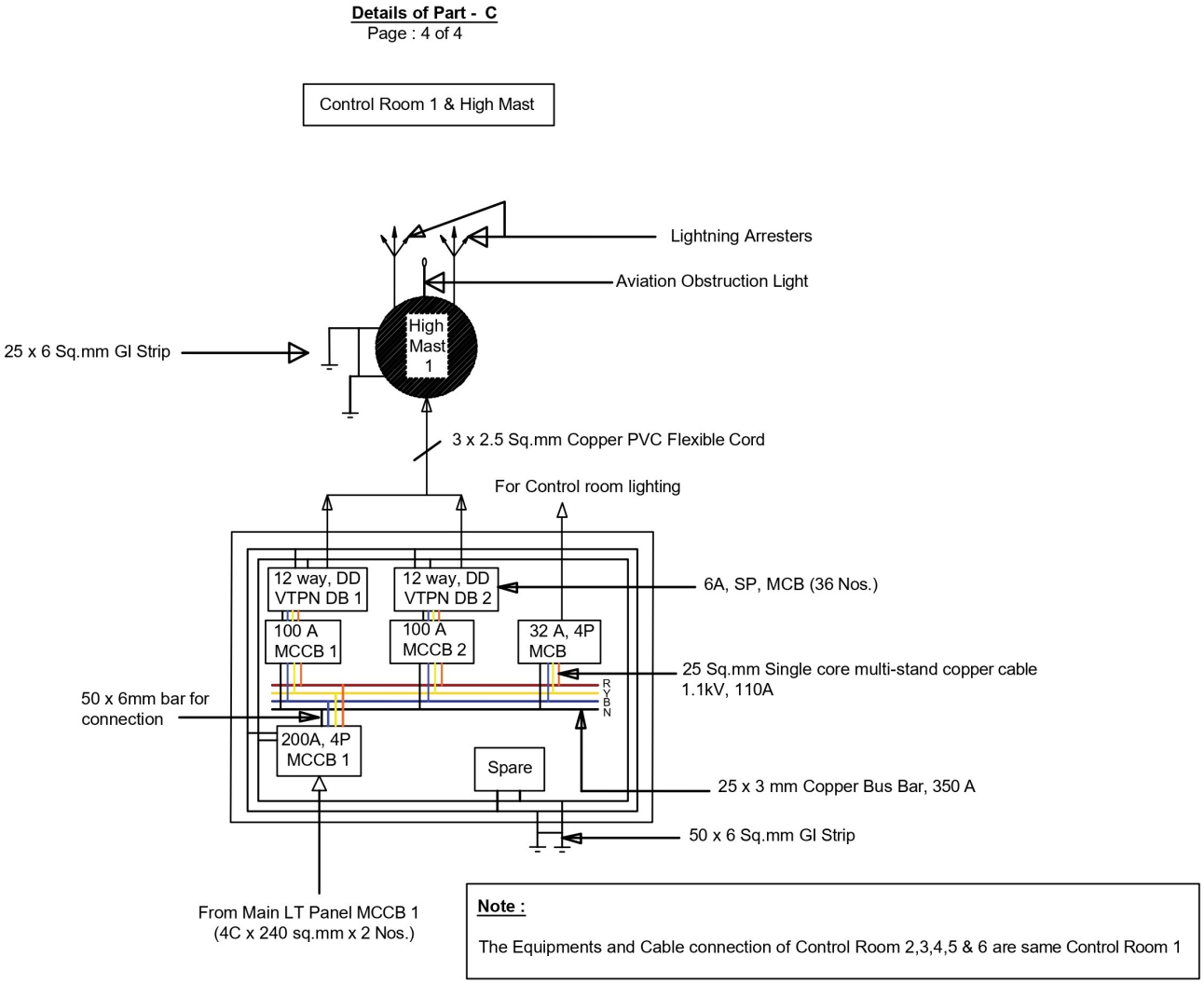
$$= \frac{70000}{\sqrt{3} \times 415 \times 0.8} = 121.73 \approx 122\ A$$

Considering factor of safety and additional load for control room itself, **200 A, 4 Pole MCCB is selected.**

To feed supply to 4 nos. 200 A MCCB and 1 spare 200 A MCCB, ACB of 1600 A capacity is chosen.
On the distribution panel 2 nos. ACBs are installed. In normal condition 1 ACB is dedicated for field load and other one for other load. But in case of failure of one ACB other one can take care of the entire load required by control rooms. 2 nos. ACB of 1250 A capacity mounted on the distribution panel for DG set. 2 nos. multi-function digital meter are fixed on the panel to measure the different electrical quantities.

11.5 Layout diagram of a control room (Part - C)

The layout diagram of control room is shown below.



The control panel consists of **200A, 4 Pole MCCB, 100A 4 Pole MCCBs, 32A 4 Pole MCB, 12 way double door VTPN DBs, 6A SP MCBs and multi-function digital meter.**

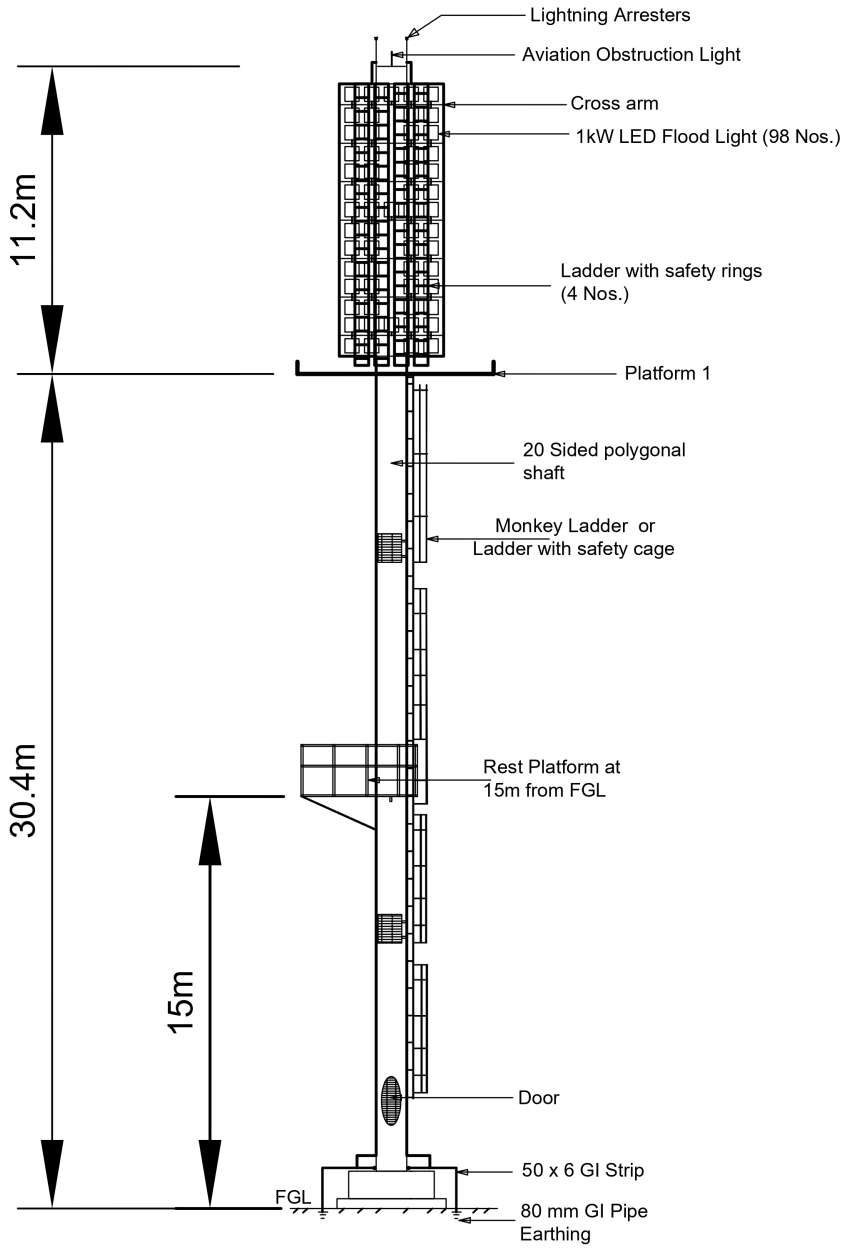
The supply fed to 200A, 4P MCCB by LT distribution panel. Each flood light on the head frame of the mast is connected to 12 way DB by 3 x 2.5 Sq.mm Copper flexible cord. Flexible cord are run through a GI cable tray. Current required by each luminaire –

$$I_{lum} = \frac{1kW}{230V} = \frac{1000}{230} = 4.35A$$

Therefore,2 nos. 12 way DD VTPN DB are sufficient to accommodate 70 nos. MCBs.

11.6 Design of High Mast

The diagram of the high mast along with head frame & accessories is appended below.



Dimensions & data relating to the high mast :

- Height of the mast = 30.40m
- No. of side of the mast structure = 20
- Head frame height = 11.20m
- Head frame width = 3.80m
- No. of cross arm = 7
- No. of ladder on top platform = 4

Chapter 12

Bill of Quantity

12.1 4 Pole Arrangement

Table 12.1: BOQ of 4 pole arrangement

A. High Tension (HT) Part :				
Sl. No.	**Description of Items**	**Qty.**	**Make**	**Reference**
1.	Construction of rooms to house HT Gears,Transformers, LT Panel as per standard specification	1 Complete set		
2.	Construction of rooms for LT Control rooms for each high mast as per standard specification	4 Nos.		
3.	Construction of High-mast tower to hold the Luminaires	4 Nos.		
4.	**12.7/22 kV grade,3C x 240 Sq.mm, HT,XLPE,round armoured Aluminium Conductor Cable as per IS: 7098, Part II/2011 with latest amendments.** i. From HT gear O/G 1 to Transformer 1 HT I/C ii.From HT gear O/G 2 to Transformer 2 HT I/C	50.00 R.M.	KEI / Gloster / Havells	http://www.greenure.in/pdf/Catalogue_Havells_Industrial_Cables_Greenure.pdf
5.	11kV, HT VCB (Vacuum Circuit Breaker), with all standard accessories and specification.	5 Nos.		
6.	3 Phase, 1MVA , 11kV/415V, dry type, indoor, delta/star distribution Transformer	2 Nos.	ABB / Schnider / Crompton / Siemens	https://library.e.abb.com/ public/1db706bcb4e74fee9d0a6db2f1e61f24/1LES1000088-ZD_en_PGTR_HiDry.pdf
7.	**11 kV, Heat Shinkable, 3C x 240 Sq.mm indoor end termination** (For HT O/G 1 gear, HT O/G 2 gear, Transformer 1 HT I/C, Transformer 2 HT I/C)	4 Nos.	Raychen / M-Seal	

B. Low Tension (LT) Part :				
Sl. No.	**Description of Items**	**Qty.**	**Make**	**Reference**
1.	**Cable**			
1.a	**4C x 300 Sqmm AL. Flat Armoured ,1.1kV grade LT XLPE Cable** i.From Transformer 1 LT O/G to LT panel 1600A LT ACB 1, 4 runs ii. From Transformer 2 LT O/G to LT panel 1600A LT ACB 2, 4 runs iii. From DG set to AMF 1 to LT Panel 1250A LT ACB 1 for DG 1, 3 runs iv. From DG set to AMF 2 to LT Panel 1250A LT ACB 2 for DG 2, 3 runs	250.00 Mtrs.	Gloster / KEI / Havells	Page : 16, https://www.havells.com/content/dam/havells/brouchers/Industrial%20Cable/Cable%20Catalogue-2016.pdf
1.b	**4C x 240 Sqmm AL. Flat Armoured ,1.1kV grade LT XLPE Cable** i. From Main panel 250A 4P, MCCB 1 to Control Room 1 250A,4P MCCB,2 runs ii. From Main panel 250A 4P, MCCB 2 to Control Room 2 250A, 4P MCCB, 2 runs iii. From Main panel 250A 4P, MCCB 3 to Control Room 4 250A, 4P MCCB via Control room 1 , 2 runs iv. From Main panel 250A 4P, MCCB 4to Control Room 3 250A, 4P MCCB via Control room 2 , 2 runs v. FromControl room 4 to Control Room 3 , 1 runs	1.00 K.M	Do	Do
1.c	**3C x 2.5 Sq.mm Copper PVC Flexible Cord** i. From Control Room to Flood Light for 4 Nos. Towers ii. From AMF 1 & 2 to DG set 1 & 2	2.00 K.M	Polycab / Gloster / KEI / Havells	https://polycab.com/product-pdf/FINAL-LTCable-Catalog.pdf

1.d	**25 Sq.mm Single core, multistand copper cable, 1.1kV grade** i. From Control room 1 Busbar to 100A MCCB 1,2,3 (For 4 Control room)	100.00 Mtrs.	Do	
2.	**MCCB/MCB**			
2.a	4 Pole MCCB, 250A, 36kA , fixed thermal and adjustable magnetic relay	9 Nos.	Legrand / Schneider / Havells	Page No. 14 (https:// www.havells. com/ HavellsProductI mages/ HavellsIndia/ Content/dam/ havells /brouchers/ dealer/br ochure/ Catalogue_Ha vells_Industrial_Switc hGear.pdf)
2.b	100A, 4Pole MCCB, 36kA, fixed thermal and adjustable magnetic relay	12 Nos.	Do	Do
2.c	6A Single Pole MCB, 10kA , C series	432 Nos.	Do	Page No. 11 (https:// havells.com/ HavellsProductIm- ages /HavellsIndia/ Conten t/dam/ havells/brouc hers/ dealer/brochure / Catalogue_Havells_ Consumer_ Switchgear.pdf)
3.	**Distribution Board (DB)**			
3.a	12 way, double door, VTPN DB with MCCB I/C & MCB O/G	12 Nos.	Legrand / Schneider / Havells	

4.	**Air Circuit Breaker (ACB))**			
4.a	**1600 A LT ACB, 4 Pole, 50kA, draw out type** (For transformers connection to LT Panel)	3 Nos.	L&T / Schneider / Havells	Page No. 6 (https:// www.havells.com/ HavellsProduct Images/ HavellsIndia/ Content/dam/ havells/brouchers/ dealer/brochure/ Catalogue_ Havells_ Air_Circuit_Breaker_ Titania_Series.pdf)
4.b	**1250A LT ACB, 4 Pole, 50kA, draw out type** (For DG sets connection to LT Panel)	2 Nos.	Do	
5.	**Finishing the end of AL. Cable by Crimping method (4 Core = 1 Set)**			
5.a	4C x 240 Sq.mm	16 Sets.	Dowell	
5.b	4C x 300 Sq.mm	40 Sets.	Do	
6.	**Finishing the end of CU. Cable by Crimping method**			
6.a	25 Sq.mm Single core, multistand copper cable	96 Nos.	Dowell	
7.	**Cable Gland, Double compresion type : (4 Core = 1 Set)**			
7.a	4C x 240 Sq.mm	16 Sets.	Dowell	
7.b	4C x 300 Sq.mm	40 Sets.	Do	
8.	**Copper Bus Bar**			
8.a	100 x 10mm, 2065A	40 Mtrs.	Austral-Wright-Metals	Page No. 2 (https:// www.australwright. com.au/ wpcontent/ uploads/2019/01/ Copper-Busbar-Rating-Table-Austral-Wright-Metals.pdf)
8.b	25 x 3 mm, 350A	80 Mtrs.	Do	Do

9.	Multi Function Digital Meter	6 Nos.	Schneider Electric	
10.	**Earthing Materials**			
10.a	25 x 6 Sq.mm GI strip	400 Mtrs.	Daga Power	
10.b	50 x 6 Sq.mm GI strip	200 Mtrs.	Do	
10.c	75 x 6 Sq.mm GI strip	50 Mtrs.	Do	
10.d	**80mm GI pipe, 3.3 m. long with all accessories** (For Transformer - 2 , Control Room - 4 , Tower - 4x2, Lightning Arrester - 4 x 2)	22 Nos.		
11.	**Luminaire**			
11.a	1 KW LED luminaire (5700K, IP65, Ra = 90)	392 Nos.	Silver-Sun	https:// www.silversunlighting.com/ descargas /F_EN_ FLC1000FW.pdf
11.b	Aviation Lamp	4 Nos.	Honeywell	
11.c	Indicating Lamp	404 Nos.	Binex Control	
12.	**GI Cable Tray with cover**			
12.a	150 x 25 x 2 mm of 3m length each	56 Nos.	AKG/ OBO/ Rm-Conn	http:// www.akgsteelind.com/preforated-cabletrays/
13.	750kVA DG set with AMF panel	2 Nos.	Power-Generation / Kirloskar	
14.	Lightning Arrester	8 Nos.	Techno-Power	

12.2 6 Pole Arrangement

Table 12.2: BOQ of 6 pole arrangement

A. High Tension (HT) Part :				
Sl. No.	**Description of Items**	**Qty.**	**Make**	**Reference**
1.	Construction of rooms to house HT Gears,Transformers, LT Panel as per standard specification	1 Complete set		
2.	Construction of rooms for LT Control rooms for each high mast as per standard specification	6 Nos.		
3.	Construction of High-mast tower to hold the Luminaires	6 Nos.		
4.	**12.7/22 kV grade,3C x 240 Sq.mm, HT,XLPE,round armoured Aluminium Conductor Cable as per IS: 7098, Part II/2011 with latest amendments.** i. From HT gear O/G 1 to Transformer 1 HT I/C ii.From HT gear O/G 2 to Transformer 2 HT I/C	50.00 R.M.	KEI / Gloster / Havells	http://www.greenure.in/pdf/Catalogue_Havells_Industrial_Cables_Greenure.pdf
5.	11kV, HT VCB (Vacuum Circuit Breaker), with all standard accessories and specification.	5 Nos.		
6.	3 Phase, 1MVA , 11kV/415V, dry type, indoor, delta/star distribution Transformer	2 Nos.	ABB / Schnider / Crompton / Siemens	https://library.e.abb.com/ public/1db706bcb4e74fee9d0a6db2f1e61f24/1LES1000088-ZD_en_PGTR_HiDry.pdf
7.	**11 kV, Heat Shinkable, 3C x 240 Sq.mm indoor end termination** (For HT O/G 1 gear, HT O/G 2 gear, Transformer 1 HT I/C, Transformer 2 HT I/C)	4 Nos.	Raychen / M-Seal	

B. Low Tension (LT) Part :				
Sl. No.	**Description of Items**	**Qty.**	**Make**	**Reference**
1.	**Cable**			
1.a	**4C x 300 Sqmm AL. Flat Armoured ,1.1kV grade LT XLPE Cable** i.From Transformer 1 LT O/G to LT panel 1600A LT ACB 1, 4 runs ii. From Transformer 2 LT O/G to LT panel 1600A LT ACB 2, 4 runs iii. From DG set to AMF 1 to LT Panel 1250A LT ACB 1 for DG 1, 3 runs iv. From DG set to AMF 2 to LT Panel 1250A LT ACB 2 for DG 2, 3 runs	250.00 Mtrs.	Gloster / KEI / Havells	Page : 16, https:// www.havells.com/ content/dam/ havells/brouchers/ Industrial %20Cable/Cable% 20Catalogue- 2016.pdf
1.b	**4C x 240 Sqmm AL. Flat Armoured ,1.1kV grade LT XLPE Cable** i. From Main panel 200A 4P, MCCB 1 to Control Room 1 200A,4P MCCB,2 runs ii. From Main panel 200A 4P, MCCB 2 to Control Room 2 200A,4P MCCB,via Control Room 1, 2 runs iii. From Main panel 200A 4P, MCCB 3 to Control Room 3 200A,4P MCCB via Control room 1 & 2 runs iv. From Main panel 200A 4P, MCCB 4 to Control Room 4 200A, 4P MCCB, 2 runs v.From Main Panel 200A, 4P MCCB 5 to Control Room 5 200A, 4P MCCB,via Contol Room 4, 2 Runs Vi.From Main Panel 200A, 4P MCCB 6 to Control Room 6 200A, 4P MCCB,via Contol Room 4 & 5, 2 Runs vii. From Control room 3 to Control Room 6, 1 Run	4.30 K.M	Do	Do

1.c	**3C x 2.5 Sq.mm Copper PVC Flexible Cord** i. From Control Room to Flood Light for 6 Nos. Towers ii. From AMF 1 & 2 to DG set 1 & 2	1.70 K.M	Polycab / Gloster / KEI / Havells	https:// polycab.com/pr oduct-pdf/FINAL-LTCable-Catalog.pdf
1.d	**25 Sq.mm Single core, multistand copper cable, 1.1kV grade** i. From Control room 1 Busbar to 100A MCCB 1,2,3 (For 6 Control room)	120.00 Mtrs.	Do	
2.	**MCCB/MCB**			
2.a	4 Pole MCCB, 200A, 36kA , fixed thermal and adjustable magnetic relay	13 Nos.	Legrand / Schnei-der / Havells	
2.b	100A, 4 Pole MCCB, 36kA, fixed thermal and adjustable magnetic relay	12 Nos.	Do	
2.c	6A Single Pole MCB, 10kA , C series	476 Nos.	Do	
3.	**Distribution Board (DB)**			
3.a	12 way, double door, VTPN DB with MCCB I/C & MCB O/G	12 Nos.	Legrand / Schnei-der / Havells	

4.	**Air Circuit Breaker (ACB))**			
4.a	**1600 A LT ACB, 4 Pole, 50kA, draw out type** (For transformers connection to LT Panel)	3 Nos.	L&T / Schneider / Havells	Page No. 6 (https:// www.havells.com/ HavellsProductImages/ HavellsIndia/ Content/dam/ havells/brouchers/ dealer/brochure/ Catalogue_ Havells_ Air_Circuit_Breaker_ Titania_Series.pdf)
4.b	**1250A LT ACB, 4 Pole, 50kA, draw out type** (For DG sets connection to LT Panel)	2 Nos.	Do	
5.	**Finishing the end of AL. Cable by Crimping method (4 Core = 1 Set)**			
5.a	4C x 240 Sq.mm	16 Sets.	Dowell	
5.b	4C x 300 Sq.mm	40 Sets.	Do	
6.	**Finishing the end of CU. Cable by Crimping method**			
6.a	25 Sq.mm Single core, multistand copper cable	96 Nos.	Dowell	
7.	**Cable Gland, Double compresion type : (4 Core = 1 Set)**			
7.a	4C x 240 Sq.mm	16 Sets.	Dowell	
7.b	4C x 300 Sq.mm	40 Sets.	Do	
8.	**Copper Bus Bar**			
8.a	100 x 10mm, 2065A	40 Mtrs.	Austral-Wright-Metals	Page No. 2 (https:// www.australwright. com.au/ wpcontent/ uploads/2019/01/ Copper-Busbar-Rating-Table-Austral-Wright-Metals.pdf)
8.b	25 x 3 mm, 350A	80 Mtrs.	Do	Do

9.	Multi Function Digital Meter	8 Nos.	Schneider Electric	
10.	**Earthing Materials**			
10.a	25 x 6 Sq.mm GI strip	500 Mtrs.	Daga Power	
10.b	50 x 6 Sq.mm GI strip	230 Mtrs.	Do	
10.c	75 x 6 Sq.mm GI strip	50 Mtrs.	Do	
10.d	**80mm GI pipe, 3.3 m. long with all accessories** (For Transformer - 2 , Control Room - 6 , Tower - 6x2, Lightning Arrester - 6 x 2)	32 Nos.		
11.	**Luminaire**			
11.a	1 KW LED luminaire (5700K, IP65, Ra = 90)	376 Nos.	Silver-Sun	https:// www.silversunlighting.com/ descargas /F_EN_ FLC1000FW.pdf
11.b	Aviation Lamp	6 Nos.	Honeywell	
11.c	Indicating Lamp	420 Nos.	Binex Control	
12.	**GI Cable Tray with cover**			
12.a	150 x 25 x 2 mm of 3m length each	72 Nos.	AKG/ OBO/ Rm-Conn	http:// www.akgsteelind.com/preforated-cabletrays/
13.	750kVA DG set with AMF panel	2 Nos.	Power-Generation / Kirloskar	
14.	Lightning Arrester	12 Nos.	Techno-Power	

Chapter 13

Design challenge and Conclusion

13.1 Design challenge :

Mere achieving the target illuminance level demanded by a specific sports facility is not the ultimate goal. The design should ensure the availability of quality light throughout the field. Again the design should be such that the project will be feasible and economical.

Therefore, it is a great challenge for a designer to meet all above needs.

13.2 Conclusion :

In the design LED luminaires are used in place of conventional luminaires due to its superiority in many aspects over the later one. But the longevity of the LED luminaire depends upon the longevity of its driver and heat management mechanism. So, attention is to be paid on the specification of the above accessories while selecting LED luminaires.

Though LED lumianires are Superior to HID luminaires but it contain Hazardous metal such as lead and arsenic. There is also chance of blue light hazard from the cool white LEDs. which affect our eyes and intern circadian rhythm.

This project work is confined to the design of a football field with 4 and 6 pole arrangement. During analysis of the above arrangements it is revealed that 6 pole arrangement is better than 4 pole arrangement as it consumes less electrical power and produces better quality of light.

Chapter 14

Future scope of study

- Due to the limited stock of fossil fuels we should look into the possibility of implementation of renewable energy sources for sports lighting.

- Further research work is needed in respect of luminaire distribution pattern so that initial and running cost of the electrical installation can be reduced without compromising the quality of light.

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