Illumination Design for Laykyun Setkyar standing Buddha statue

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Abstract: *In the past human beings passed most of their time out of doors and their lighting needs were provided by nature. Today, however, most of human's time is spent in buildings where artificial lighting plays an important role. The purpose of illumination is the creation of favourable conditions for seeing. As Myanmar is a nation which has developed the Buddhism, the pagodas are decorated with electric lights to get great respect. Laykyun Setkyar standing Buddha statue lies the south-east of Monywa Township. As Laykyun Setkyar standing Buddha statue is (424) feet high, hollow type and it is the second tallest statue in the world, it can be revered from the surroundings of Monywa Township. By using lighting system, the standing Buddha statue is more revered at night than at day light because of its golden ray radiation at night. Lighting system cannot be easy made due to the large standing Buddha statue. So the indoor lighting system design by Lumen method and illumination level for the face, body and altar of the standing Buddha statue by point-by-point method are calculated.*

Key Words: *Face, Body, Altar, Indoor lighting, Lumen, point-by-point.*

1. INTRODUCTION:

Light is visible radiation, evaluated according to the sensitivity of the human eye. When an incandescent lamp is switched on, the thin filament is heated to so high a temperature by the electric energy fed into it that it begins to glow and emit radiation. The purpose of every artificial system of lighting is to complement daylight or replace it entirely. To get a good lighting installation, requirements should be considered the following data. A first essential is that the eye allows the worker to carry out his task without unnecessary effort. And the next fact is that satisfactory illumination is a first requirement. And then, the end fact is that electrical distribution is involved in lighting system.
The remainder of this paper is organized as follows. About the lighting system design is presented in section II. The illumination level is presented in section III. The calculation of indoor lighting system results are given in section IV. The concluding remarks are given in section V.

2. LGHTING SYSTEM DESIGN:

An illumination engineer must also have appreciation of art and architecture in order to produce pleasing effects. Lighting should be considered as a structural material to be used in a building to help it serve various functions. To treat lighting like furniture and decoration equipment that can be added after the building has been designed and completed. Poor lighting results in dangerous effects like eye strain, headaches, accidents due to insufficient lighting or to glare. Artificial sources of high luminosity are placed directly in the field of vision or so placed that reflected glare will be experienced from polished surfaces. Good lighting, apart from having aesthetic and decorative aspects, reduces accidents, increases the production in the factories and improves the general health of the community due to reduction of eye-strain. For good lighting a close cooperation between the artist, the architect and an illumination engineer is desired. So far only the illumination at the centre of an image has been considered, but the distribution of illumination over a wide field is often important.

The lighting system may involve the need to provide specific levels of horizontal, vertical, or other angular illuminance in selected areas, to achieve greater attention or enhance visibility. Calculations are affected by the maintenance factors and the recommended illumination levels for different activities. Major differences occur because of the types of luminaries and lamps that are normally used, and the manner in which the coefficient of utilization is derived. For outdoor lighting system, if possible, the luminaire mounting height should be at least one-half the width of the area being lighted. Lower mounting heights will reduce utilization and uniformity. The most difficult part of area-lighting design is determining the location of the edges of the lighted area in relation to the floodlight aiming line. This is needed to determine the lumens that will fall inside the area. The total lumens that fall on the area are the sum of the lumens falling inside the area's boundary.

Laykyun Setkyar standing Buddha statue is very high and wide and so it is not easy to get a good illumination. Figure 2 shows the layout of the standing Buddha statue lighting system design. This standing Buddha statue is lighted

by using sodium lamps, mercury lamps and metal-halide lamps, etc. The miniature breakers are used to protect the lamps from the excess current. These lamps are fixed at towers and cement-poles. The towers and cement-poles are (50) feet and (10) meters high for each. The average distance is (323) feet between the towers and the standing Buddha statue.

The face of the standing Buddha statue is lighted by using two high pressure mercury lamps (2000W) and one metal-halide lamp (1500W) at the towers. And the body of this Buddha statue is lighted by using two high pressure sodium lamps (1500W) at this tower. And, the average distance is (137) feet between the cement-poles and the standing Buddha statue. Ten high pressure sodium lamps (1000W) and one metal-halide lamp (400W) light the body and the altar of the statue of Buddha at the cement-poles. So the illumination level of the face, body and altar of the standing Buddha statue are calculated according to the theory. The intensity and lumen of lamps are described.

And the indoor lighting system for the standing Buddha statue is modified with new design in this paper. The fluorescent lamps and low pressure mercury lamps are used in the indoor lighting system. For indoor lighting system, the illumination level is determined from the international standard table and the type of lighting system is chosen for every room to be lighted. The numbers of lamps from the ground floor to the twenty-sixth floor are calculated with the help of theory and tables concerning the indoor lighting system.

Figure 1. Laykyun Setkyar standing Buddha statue.

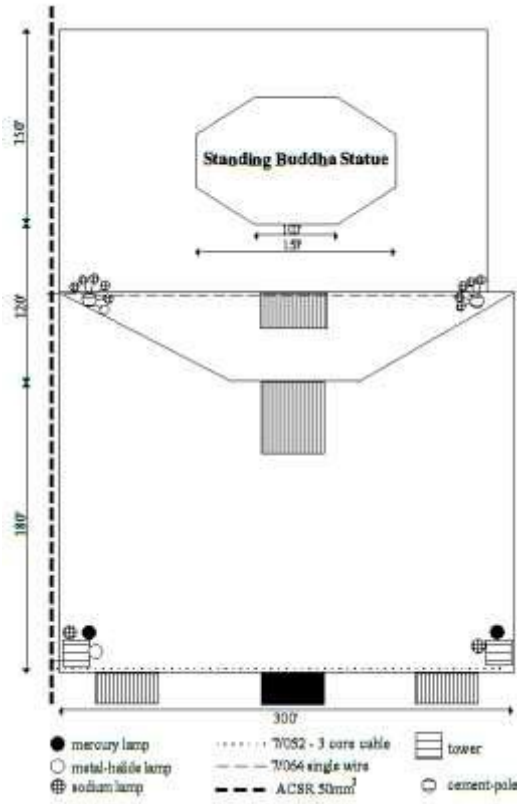


Figure 2. Layout of the standing Buddha statue lighting diagram.

3. THE ILLUMINATION LEVEL FOR THE STANDING BUDDHA STATUE:

The **point-by-point method** of calculation is useful for determining the foot candles produced by a direct lighting reflector or a floodlight or searchlight projector. The point-by-point method of lighting calculation is based on the "inverse square law", i.e., that the intensity of light varies inversely as the square of the distance from the light source to the point of measurement. From the candle power distribution curve of a reflector, the foot candles at any given point may be computed from the formula.

$$E\ (\text{foot-candles}) = \frac{I\ (\text{candlepower})}{d^2\,(\text{distance in feet})} \quad (\text{Normal to the beam}) \qquad \text{Equation 1}$$

$$E\ (\text{foot-candles}) = \frac{I}{d^2} \times \text{cosine of angle } \theta \qquad \text{Equation 2}$$

where, E = illumination; I = the luminous intensity; d = the distance from the light source to illuminated surface
θ = the angle between the light ray and a horizontal line from that point to the working surface.

The illumination levels of the face, body and altar of the standing Buddha statue are calculated by using point-by-point method. The relationship of equations between illuminations units are

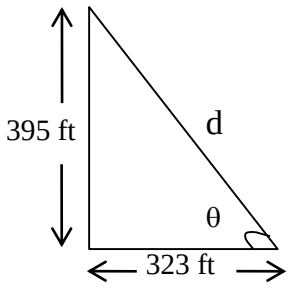
1 Lumen = 4π × Candle power of illumination and
1 Foot-candle = 10.764 lux.

The Illumination Level of the Face

In the north tower, as shown in the Figure3, the type of lamp fitting is mercury lamp fitting and its power is 2000W. The luminous flux of lamp, ø is 120000 lumens.

Therefore, the luminous intensity, $I = \frac{120000}{4\pi}$

= 9549.3 candlepower



$\tan\theta = \frac{395}{323}$

= 1.2229

θ = 51°

By Pythagoras' theorem:

$d^2 = (395)^2 + (323)^2$

= 260354

d = 510 ft

By the equation 2,

The illumination, $E = \frac{9549.3}{(510)^2} \cos 51^\circ$

= 0.023 foot candles

= 0.023 foot candles × 10.764

= 0.25 lux

In the south tower, the type of lamp fitting is mercury lamp fitting and its power is 2000W. The luminous flux of lamp, ø is 120000 lumens. Therefore, the luminous intensity I is 9549.3 candlepower.

In the north tower, the type of lamp fitting is metal halide lamp and its power is 1500 W. The luminous flux of lamp, ø is 161000 lumens.

Table 1. Values of Illumination at Test Points for the Face

Contributing luminaries	Distance (ft)	Angle (degree)	Illumination at test points (lux)
High pressure mercury (2000W) (north tower)	510	51	0.25
	503	50	0.26
	495	49	0.28
	487	48	0.29
	500	51	0.26
	493	50	0.27
	485	49	0.29
	477	48	0.30
	520	51	0.24
	513	50	0.25
	505	49	0.26

	497	48	0.28
High pressure mercury (2000W) (south tower)	513	51	0.25
	505	50	0.26
	498	49	0.27
	490	48	0.29
	523	51	0.24
	515	50	0.25
	508	49	0.26
	500	48	0.28
	503	51	0.26
	495	50	0.27
	488	49	0.28
	480	48	0.30
Metal halide lamp (1500W) (north tower)	512	51	0.33
	504	50	0.35
	496	49	0.37
	489	48	0.39
	502	51	0.35
	494	50	0.36
	486	49	0.38
	479	48	0.40
	522	51	0.32
	514	50	0.34
	506	49	0.35
	499	48	0.37
Total illumination level			10.75

The Illumination Level of the Body

In the north tower, as shown in the Figure 3, the type of lamp fitting is high pressure sodium lamp and its power is 1500 W. The luminous flux, ø is 189000 lumens.

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In the north and south cement-poles, the type of lamp fitting is high pressure sodium lamp and its power is 1000 W. The luminous flux, ø is 125000 lumens.

Table 2. Values of Illumination at Test Points for the Body (Towers)

Contributing luminaries	Distance (ft)	Angle (degree)	Illumination at test points (lux)
High pressure sodium (1500W) (north tower)	483	48	0.46
	433	42	0.64
	389	34	0.89
	354	24	1.18
	332	13	1.43
	448	48	0.54
	398	42	0.76
	354	34	1.07
	319	24	1.45
	297	13	1.79
	518	48	0.40
	468	42	0.55
	424	34	0.75

	389	24	0.98
	367	13	1.17
High pressure sodium (1500W) (south tower)	484	48	0.46
	434	42	0.64
	391	34	0.88
	356	24	1.17
	334	13	1.41
	519	48	0.40
	469	42	0.55
	426	34	0.74
	391	24	0.97
	369	13	1.16
	449	48	0.54
	399	42	0.76
	356	34	1.06
	321	24	1.44
	299	13	1.76
Total illumination level			28

Table 3. Values of Illumination at Test Points for the Body (Cement-poles)

Contributing luminaries	Distance (ft)	Angle (degree)	Illumination at test points (lux)
High pressure sodium (1000W) (north and south cement-poles)	386	69	0.26
	320	64	0.46
	257	57	0.88
	200	46	1.86
	157	27	3.87
	346	69	0.32
	280	64	0.60
	217	57	1.24
	160	46	2.91
	117	27	6.97
	426	69	0.21
	360	64	0.36
	297	57	0.66
	240	46	1.29
	197	27	2.46
Total illumination level			24.35

For 4 numbers of sodium lamps,
E = 24.35 lux × 4
= 97.4 lux
For 2 numbers of cement-poles
E = 97.4 lux × 2
= 194.8 lux
Therefore, the total illumination level for the body of the standing Buddha statue is 222.8 lux.

The Illumination Level of the Altar

In the north cement-pole, as shown in the Figure 3, the type of lamp fitting is high pressure sodium lamp and its power is 1000 W. The luminous flux of lamp, ø is 125000 lumens. So, the luminous intensity I is 9947.2 candlepower and the distance is 185 ft.

By the equation 1,

The illumination, $E = \frac{9947.2}{(185)^2}$

= 0.291 foot candles

= 0.291 foot candles × 10.764

= 3.13 lux

The metal-halide lamp is also fixed in this cement-pole and its power is 400W and the distance d is 97 ft. The luminous flux, ø is 38000 lumens.

So, the luminous intensity $I = \frac{38000}{4\pi}$

= 3024 candle power

By the equation 1,

The illumination, $E = \frac{3024}{(97)^2}$

= 0.321 foot candles

= 0.321 foot candles × 10.764

= 3.46 lux

In the south cement-pole, the type of lamp fitting is high pressure sodium lamp and its power is 1000 W. The luminous flux of lamp, ø is 125000 lumens. So, the luminous intensity I is 9947.2 candlepower and the distance d is 180 ft.

By the equation 1,

The illumination, $E = \frac{9947.2}{(180)^2}$

= 0.307 foot candles

= 0.307 foot candles × 10.764

= 3.30 lux

Table 4. Values of Illumination at Test Points for the Altar

Contributing luminaries	Distance (ft)	Illumination at test points (lux)
High pressure sodium (1000W) (north cement-pole)	185	3.13
	125	6.85
	97	11.38
High pressure sodium (1000W) (south cement-pole)	180	3.30
	117	7.82
	82	15.92
Metal halide (400W) (north cement-pole)	97	3.46
	143	1.59
	191	0.89
Total illumination level		54.34

Table 5. Result Data for Illumination Level of LaykyunSetkyar Standing Buddha Statue

Types of the working area	Illumination level (lux)	Type of lamp	Watt	Number of lamps
The face	10.75	High pressure mercury	2000	2
		Metal halide	1500	1
The body	222.8	High pressure sodium	1500	2
			1000	8
The altar	54.34	High pressure sodium	1000	2
		Metal halide	400	1

4. THE CALCULATION OF INDOOR LIGHTING SYATEM:

Good interior lighting is governed by intensity, distribution, using soft and well diffused light and colour. General lighting controlled to suit psychological moods. Daylight (natural) illumination constantly varies with weather, time of day and season. The minimum daylight illuminance is twice the artificial illuminance that is sufficient for the required task location of lamps depends on candle power, maximum allowable spacing, height at which located, position of obstructions (if any) and required distribution of light. Colour reflectance from the interior finishing affects utilization.In planning a general lighting system for a working area the aim is to provide substantially a uniform level of illumination throughout the room. This eliminates spottiness and dark corners and makes the entire area equally suitable as a work space or for display, sales, or other general purpose. The number of outlets to provide for any given area is determined by the maximum allowable spacing between lighting units and is in turn regulated by their height above the floor. The spacing for uniform illumination on the work depends upon the height of the light source above the surface to be illuminated.The number of lamps can be calculated by **Lumen method**.

$$\text{number of lamps: } n_{lamps} = \frac{E \times S \times d}{\phi \times \eta} \qquad \text{Equation 3}$$

E = the illumination; S = the working area; d = maintenance factor; ø = luminous flux of lamp; η = utilization factor

The LaykyunSetkyar standing Buddha statue is built of octagonal form. There are 31 floors in this standing Buddha statue, among them only 26 floors are need to light. With the help of the Lumen method the number of fittings is calculated to install how many light sources are needed to obtain the required illumination for indoor lighting from ground floor to twenty-six floor of the standing Buddha statue. The illumination required in the room is determined from the standard illumination table. Buddha statues are decorated with mercury lamps to get greatest respect. For indoor lighting,the low pressure mercury lamp and fluorescent lamp are selected. The result data for indoor lighting system design is described with table and figures.

Firstly, the numbers of lamps in the room are calculated from the ground floor to the second floor. Assume that all the data are the same for these floors. The fluorescent lamps (40W) and low pressure mercury lamps (65W) are used and their luminous flux ø are 2650 lm and 3900 lm. This calculation is divided into two parts including a central room in each floor. 60 lux is regarded as necessary for illumination E under working area.

The measurements of the outside room are: length l= 35 m, width w= 30 m and height h= 3.6 m. The ceiling is white colour; the reflection factor can be taken to be 70%. The reflection factor of the walls is 30%. The working area is 0.3 m above the floor.To determine the utilization factor η , the **room index k** is calculated with the formula

$$k = \frac{(2 \times l) + (8 \times w)}{10 \times h} \qquad \text{Equation 4}$$

where, l = length in metres; w = width in metres; h = height in metres

By the equation 4, k = 11.1, whenever the room index is greater than 10, its influence on the efficiency differs so little from that with a room index 10, that in such cases it is always taken that k=10. The reflection factor of ceiling and walls are r_c=0.7 and r_w=0.3. So, the utilization factor η =0.69 and the maintenance factor d=1.4.

For the outside room, it is necessary to have good lighting; roughly 35 lux. The area of central room is 270 m^2. Tocalculate the number of lamps fitting, the needed data are d=1.4, Ø = 2650 lm, η = 0.69, E = 35 lux and the net area S = 660m^2. By the Lumen method, n_{lamps} = 17.7. Therefore 18 mounting rails are required for outside room. Similarly the 2 numbers of fluorescent lamp and the 4 number of low pressure mercury lamps are installed to have good lighting for the central room.

For the ground to second floor, the 20 numbers of low pressure mercury lamps are fitted. Similarly, the number of lamps fitting are calculated and described with the Table 6 and figure 3 to 6 for every floor. This lighting design has sufficient light for all room. The quality and economic of lamps should be chosen in the lighting system.

Table 6. Result Data for the Number of Lamps of the Indoor Lighting System

Types of floors	Number of lamps	Type of lamps	Illumination level (lux)
Ground floor to Second floor	20	Fluorescent (40W)	60 × 3
	4	Low pressure mercury(65W)	
Third floor	2	Fluorescent (40W)	50
	4	Low pressure mercury (65W)	
Fourth floor to Ninth floor	10	Fluorescent (40W)	50 × 6
Tenth to Twenty-Sixth floor	12	Fluorescent (40W)	50 × 17

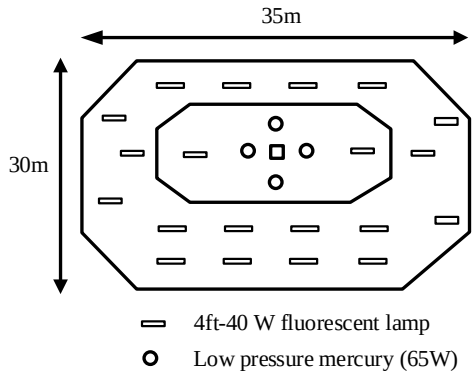

Figure 3. Ground floor to second floorindoor lighting system design

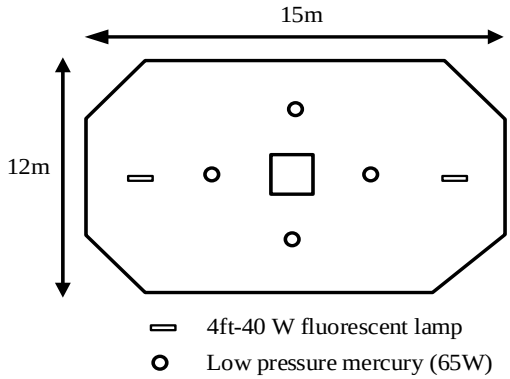

Figure 4. Third floor indoor lighting system design

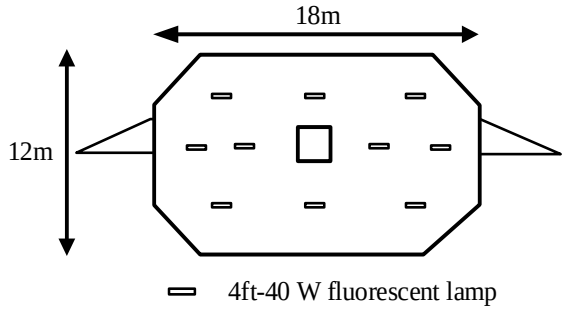

Figure 5. Fourth floor to ninth floor indoor lighting system design

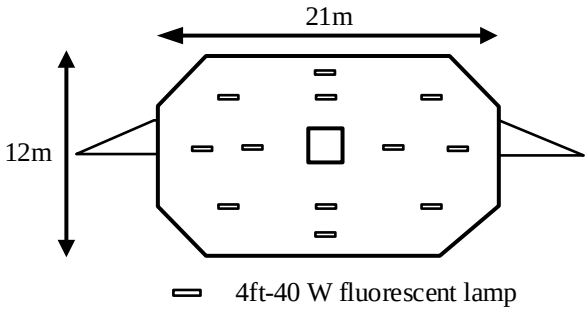

Figure 6. Tenth floor to twenty-six floor indoor Lighting system design

5. CONCLUSION:

Result illumination level for standing Buddha statue have in visible condition. The lighting system design has sufficient light for all room. The quality and economic of lamps are chosen in this lighting system. The technical challenge for the lighting is to produce a miniature point source that delivers high efficiency, high colour temperature and long lifetime.Many modern light strands are composed of LEDs- light emitting diodes. LEDs are also more efficient than fluorescent light bulbs, which require less electricity than Edison's invention to excitegases to emit light. Some LEDs under development require 10 times less electricity than an equivalent conventional light bulb and less than half the electricity required by a fluorescent light source.

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