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Design Implementation and Analysis of Energy Efficient Illumination Scheme for AISSMS IOIT, Pune

Sayali Paraye
Electrical Engineering
AISSMS IOIT, Pune,India

Aishwarya. S. Dhaigude
Electrical Engineering
AISSMS IOIT, Pune,India

Sayali Ghodke
Electrical Engineering
AISSMS IOIT, Pune,India

Pragati .W.Sontakke
Electrical Engineering
AISSMS IOIT, Pune,India

S. M. Chaudhari
Assistant Professor
AISSMS IOIT, Pune,India

***Abstract*— Lighting load is a major component of electrical load in an educational institute. Almost 20% of load is lighting load thus it is the major area of concern related to energy conservation. An attempt is made in this project to analyze the existing lighting illumination scheme of particular sections in an educational institute. Illumination level is quantified using standard measurement technique. The light pack software is used for detailed analysis. The calculations as per conventional method related to illumination scheme design are also included. Revised illumination scheme is proposed taking into consideration the energy conservation and energy efficiency. The revised illumination scheme provides improvement in quality of illumination and energy efficiency. The payback calculations are also included to justify the economics of revised illumination scheme.**

Keywords— Illumination, power quality, power consumption, LITE PACK, LUX meter.

I. INTRODUCTION

The illumination should provide favorable visual performance, visual comfort, ease of seeing and safety. Most of the academic activity involves good visual performance which can be achieved with proper illumination. Educational institute comprise of different occupancies like classroom, library, laboratory, corridor, washrooms, multipurpose hall, administrative office.

Since lot of work requires clear visibility illumination is an important aspect. Average illumination as per standard is as follows;

Table no. 1

Sr no.	Occupancies	Standard average illumination (LUX)
1.	Classroom	250
2.	Library	300
3.	Laboratory	300
4.	Multipurpose hall	500
5.	Administrative office	500
6.	Corridor	100
7.	Washroom	100

The quality of existing illumination scheme is studied by standard measurement, calculation and by the use of software. Revised illumination scheme is proposed which gives better quality of education and better energy efficiency. All the measurements are carried out by using LUX meter Measuring range : 0-50000 lux .

A sample of payback period calculation for respective luminaries is also presented.

But modern luminaries like CFL's and LED's produce harmonics as electronic circuits are used for their ignition. Due to use of power electronic circuitry the load becomes nonlinear, which in turn impacts on the power quality of consumer side low voltage grids and ultimately on utility and generation sides .The concern for the quality of power is increasing amongst both electric utilities as well as end users of electric power. Hence maintaining proper illumination without compromising the power quality is the main focus of this project.

II. OBJECTIVES

These are the objectives which are obtained by project analysis:

1. To study the existing lighting scheme of the institute.
2. To analyze the existing system by carrying out various steps.
3. To work out the replacement of fluorescent bulbs with the LEDs for improving illumination and attain maximum efficiency and to maintain power quality.
4. To carry out payback period calculations and suggest the most economical combination of luminaries.

III. METHODOLOGY

Indian standard was adopted by the Indian Standards Institutions on 19 march 1984.This standard has been prepared to deal with the special aspect of lighting for educational institutes and shall be read in conjunction with

IS :3646(PART I)-1966*, IS : 3646(PART II)-1966* and IS :3646(PART III)-1968*

This standard covers the principles and the practices governing good lighting in educational institutes and stresses on the importance of good visual environment for education. It also recommends the level of illumination and quality requirements to be achieved by general principles of lighting.

a) EQUIPMENTS REQUIRED

For the analysis purpose the following instruments-

Table no. 2

LUX meter	It is an analog or digital electronic device that measures the illumination level of the area.
LITE pack software	It is a tool for visually designing. Havel's LITE pack version 3.00. The parameters are entered in the software and the illumination distribution is obtained.

b) COLLECTION OF DATA

The area of respective occupancies is measured .The illumination at different points in respective areas is measured and average illumination is calculated.

c) OBTAINING AVERAGE LUMENS BY USE OF LITE PACK:

The existing illumination scheme performance is analyzed using LITE PACK software. Different parameters and physical dimensions are given as input to carry out the analysis. The report generated through this software contains-3D ISO LUX diagram, Gray scale pattern, Light distribution, Illumination distribution in tabular form giving maximum ,minimum, average values along with the different ratios of these quantities.

d) COMPARING THE DATA FOUND OUT BY MANUAL METHOD AND SOFTWARE

The data obtained from the manual interpretation and software is compared and the accordingly the suggestions are provided.

e) SUGGESTIONS

Suggesting replacement of fluorescent bulbs with LEDs for maximum efficiency and maximum power output. Table no. 3

IV. ANALYSIS OF EXISTING ILLUMINATION SCHEME

Table no. 3

LOCATION	EXISTING AVERAGE ILLUMINATION LEVEL (Measured by Lux-meter)	AVERAGE ILUMINATION LEVEL AS PER LITE PACK SOFTWARE	Illumination required as per the Indian Standards	REMARK
108-B Meeting Room	55.9	58.8	250	Not sufficient
010-A Physics Laboratory	154.57	105	300	Not sufficient
010-B Mechanical Laboratory	61.62	105	300	Not sufficient
010-C Civil Laboratory	91.6	55	300	Not sufficient

V. POINT-BY-POINT LAYOUT- 3D LUX WEB

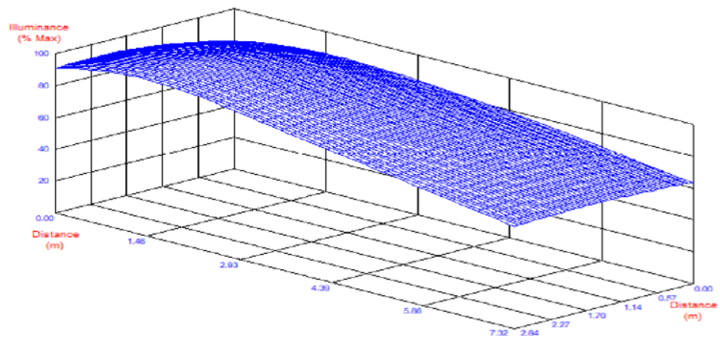

Fig.1. Room No. 108 B

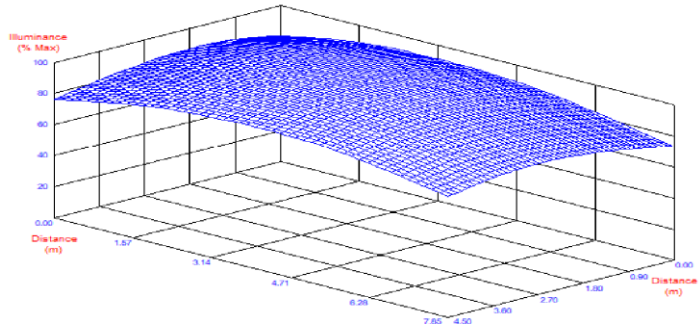

Fig.2. Room No.010. A

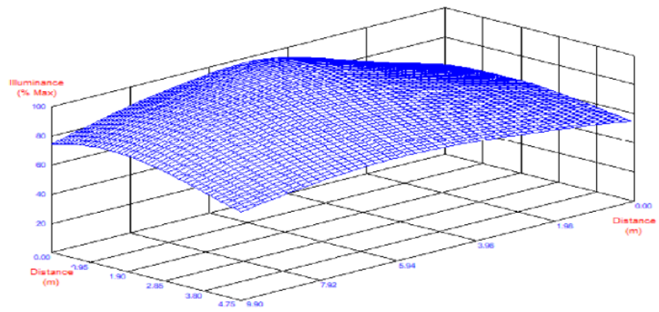

Fig.3. Room No. 010 B

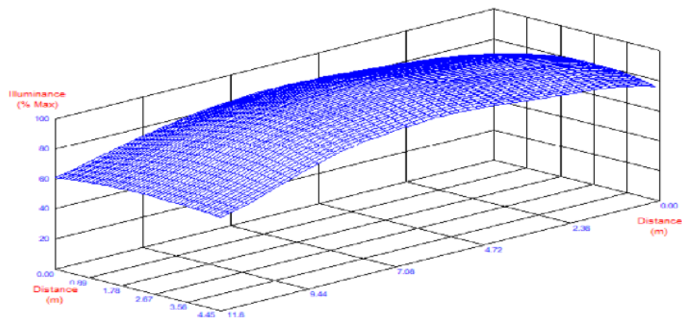

Fig.4. Room No. 010 C

VI. PAYBACK PERIOD CALCULATIONS

Payback period is the time taken by a business investment to recover its initial outlay in terms of profits or savings.

Payback period=Initial investment/annual payback.
Example.

For Room No. 108 (B)-

(a) Determination of the type, number and operational schedule of the lamps currently installed.
This will require a room inspection, in order to determine the characteristic of current installation. Following results are obtained:
Lamp type – 40 watt, T12 fluorescent, 4ft 1200mm
No. of lamps -12, Total Lumen output= 2300Lumes
Operation schedule – 7 hrs.

(b) Estimate demand in kilowatt and energy consumption in kWh:
The demand and consumption can be calculated by
Demand (kW) = [no. of lamps x power per lamp (w)]/1000
= [12x40/1000]
= 0.48kW
Energy kWh = [Demand (kW) x operational hours]
= [0.48x 7]/30
= 0.112kWh
(c) Estimate demand and consumption with the energy efficient alternative and compare
Consider a LED alternative is available which replaces the current lamps:
Type of LED – 16 watt, T8 equivalent LED Tube, Total Lumen output= 2300 Lumens
No. of equivalent LED – 12
Demand (kW) = [12x16]/1000
= 0.192
Energy (kWh) = [Demand (kWh) x operational hours]
= [0.192 x 7]/30
= 0.0448
Comparison:
Demand reduction = 0.48Kw - 0.192kW
= 0.288
Consumption reduction = 0.112 kWh/mo - 0.448 kWh/mo
= 0.336 kWh/mo

MSEDCL Charges=14.8 Rs/kWh
Total saving
= 14.8x0.336 Rs /mo
=4.972 Rs /mo.
Additional investment in LED
= (LED bulb cost) - (Fluorescent bulb cost)
= (200-50) Rs
=150Rs
Payback Period
=Additional investment / total saving
=150/4.972 Months
=30.168 Months
=2.51 Years.

In this scenario energy need of the lighting system is reduced by 40%, however this only considers direct energy savings from the lighting upgrade and it has a payback period of 2.51 years.

On the similar basis the calculation is carried out for the remaining occupancies.
The saving is 4.972Rs per month.
The payback period is 2.51 years.

Summarization of savings per month and payback period:

Table no.4

Sr.no	Room No.	No. of lights	kWh (fluorescent)	kWh (LED)	Total saving (Rs/mo)	Payback period (Years)
1.	108 B	12	0.112	0.0448	4.972	2.51
2.	10 A	8	0.074	0.029	0.666	1.8
3.	10 B	20	0.186	0.074	1.657	3.4
4.	10 C	6	0.056	0.0224	0.497	2.09

The average of the payback period is 2.45 years.

IV CONCLUSION

- We can conclude that the existing illumination system is not enough to provide an optimum visual environment for both students as well as faculties.
- In addition to the data mentioned in –IV and in table no. 4, the analysis of other occupancies is also carried out on similar basis. The existing and expected average illumination for these occupancies is summarized in following table:

Table no. 5

Sr no.	Occupancies	Existing average illumination (lumens)	Required average illumination (lumens)
1.	Classroom	170	250
2.	Library	250	300
3.	Laboratory	150	300
4.	Multipurpose hall	250	500
5.	Administrative office	300	500
6.	Corridor	70	100
12	Washroom	50	100

- It can be seen from the above table that the average illumination of the existing system is not sufficient and changes in luminaries is to be done.

- Replacement of fluorescent bulb with the CFLs for maximum efficiency and to meet the required average illumination.
- After replacement the payback period is of 2.45 years, which means it will require 2.45 years to recover the initial expenses that were required to install all the LEDs. The life of LED luminaire is about 6 years.

ACKNOWLEDGMENT

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