EVALUATION OF LIGHTING ENERGY PERFORMANCE OF TRADITIONAL AND MODERN INSTITUTIONAL BUILDINGS.

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ABSTRACT: As Industrialization has gained speed, Energy Consumption and given harm to the Environment has become one of the biggest global problems. Designing buildings and constructing them with conventional methods cause damages to the environment and increase energy consumption. Therefore in order to achieve best results to reduce the impact of buildings over the environment, a case study has been done with the support of informative literature and calculations. This literature has been carried out to show forth the works of various international designers with their observations, the case study has been carried out to compare two styles of buildings: vernacular and modern. The buildings chosen are the College of Engineering (main building) and the administrative building in the campus of Anna University, Chennai. It is found that the orientation of the buildings plays a significant role in the lighting energy of buildings. In general, for office rooms, illuminance provided by artificial lighting is 40% lower than that required. But sufficient lighting is provided by natural lighting with a daylight factor of 9%.

Author Keywords: Revit, eQUEST, Zoning, Lighting Design, Co-efficient of Utilization.

1 INTRODUCTION

Energy consumption in buildings contributes more to world's total end use of energy. In India, buildings account for more than 30 to 40 percent of total electricity consumption as per the U.S Energy Information Administration (EIA). Out of this 19% is used for indoor lighting (EIA).

India's current power production capacity is unable to meet the expected energy demand. To lower the electricity usage and increase the energy performance of both new and existing buildings, some general precautions must be taken. Designing the buildings for energy efficiency is necessary to meet the future needs.

2 OBJECTIVE OF THE STUDY

The objective of this project is to

- Make a parametric study of the building with respect to orientation, shape and zoning of the building.
- Conduct Artificial Lighting design studies on buildings.

3 SCOPE OF THE STUDY

This study will present a standardized level of lighting energy performance of an existing building. The study also includes the calculation of Lighting Design of two buildings under study.

4 REVIEW OF LITERATURE

Ho Yang et al. (2010) studied the Economic analysis of the daylight-linked lighting control system in office buildings. The objective of the study was to perform an economic analysis of the daylight-linked automatic on/off lighting control system installed for the purpose of energy savings in office buildings. For this, a building was chosen as a typical example, and the energy cost was calculated by using the daylight and building energy analysis simulation. Also, the result for total energy consumption showed that, when lighting control was applied, this was reduced by 8.5% when the glazing ratio was 100%, 8.2% for 80%, and 7.6% for 60% when compared to non-application. **Irene Wong (2012) et al.** studied the simulation and experimental studies on natural lighting in enclosed lift lobbies of high rise residential buildings by remote source solar lighting. The lift lobbies in these buildings are enclosed without windows and their floor heights are restricted to not more than 2.8 m. Electric lighting is switched on continuously for 24 h a day. Buildings accounts for nearly half of the total primary energy use in the territory. This project investigated the potential of applying remote source solar lighting technology to introduce natural lighting into the enclosed lift lobbies. The overall transmittance efficiency of the system was simulated to be 39%. **Nikolaos et al. (2012)** studied the Implementation conditions for energy saving technologies and practices in office buildings. The assessment of the available lighting technologies in use in office buildings, showed that the installation of lighting saving technologies was positively influenced by a number of parameters, such as high annual financial turnover, recently established companies and companies managed by older, highly educated and energy aware people. The potential energy saving from the application of different energy efficiency technologies in lighting was: 75% from the replacement of tungsten filament lamps with compact fluorescent lamps; 10% from the replacement of 38 mm diameter fluorescent tubes with 26 mm diameter fluorescent tubes; and 25% with replacement of tungsten filament display lights with tungsten halogen lamps.

Energy saving for electrical lighting and reduction of cooling load studied by **E.J. Gago et al. (2015)** shows that the residential sector is responsible for approximately a quarter of energy consumption in Europe. This consumption, together with that of other buildings, mainly from the tertiary sector, makes up 40% of total energy consumption and 36% of CO_2 emissions. Artificial lighting makes up 14% of electrical consumption in the European Unionand19% worldwide. It is possible to reduce energy consumption and therefore CO_2 emissions into the atmosphere. Lancashir et al. reported that each kWh of energy saved prevents the emission of 680.39 g of carbon dioxide, 5.67 g of sulfur dioxide, and 2.27 g of nitrogen oxide. Skylight systems are inappropriate for direct application in the tropics to balance the thermal and lighting loads. Therefore, these systems should be integrated by using shading, glare protection, proper use of reflective surfaces, reflectors, prisms and multi-pane, using splaying and wells for skylight, as well as double-layered roof system, and taking advantage of different geometries, roof angles, orientations, and complicated roof profiles. **Tomas Mendez Echenagucia et al. (2015)** studied the early design stage of a building envelope for multi-objective search through heating, cooling and lighting energy performance. By means of genric algorithms, a multi-objective search was performed with the aim of minimising the energy need for heating, cooling and lighting of a case study. The investigation was carried out for an open space office building by varying number, position, shape and type of windows and the thickness of the masonry walls. The search was performed through an implementation of the NSGA-II algorithm, which was made capable of exchanging information with the EnergyPlus building energy simulation tool. Energy demand, system loads, construction and operating cost, thermal comfort, life cycle cost, lifecycle environmental impact and CO_2 emissions are among the most investigated objectives in the building sector. Building operation and optimal scheduling strategies were also investigated. An optimisation of both envelope and HVAC systems was performed in. Even though a combined optimisation of envelope and HVAC systems was found to be preferable to a sequential approach where the HVAC systems are optimised after the envelope, only slightly better results were obtained at the expense of a considerable increase of the computational run time. Results retrieved from the box plot elaborations highlighted a small Window-to-Wall Ratio of the building in all locations. Pareto front solutions were characterised by very low WWR values especially in east, west and north exposed facades. The area of the south facing windows was higher compared to the other orientations and characterised by a wider spread.

Building lighting energy consumption prediction for supporting energy data analytics has been studied by **Kadir Amasyali and Nora El-Gohary (2016).** Building energy software tools such as EnergyPlus and eQuest are being widely used for energy consumption prediction. In order to predict energy consumption of buildings without many input parameters, data-driven models were developed. These studies can be classified based on their learning algorithms, spatial scales, temporal granularities, types of energy consumption prediction, and types of dataset. Learning algorithms include support vector machines (SVM), artificial neural networks (ANN), decision trees, and other statistical algorithms. Economic feasibility of maximizing day lighting of a standard office building with efficient electric lighting has been studied by **Marc Fontoynonta et.al (2016).** Certain architectural special features increased the proportion of the indoor area with sufficient daylight by up to 40%, with an increase of construction costs ranging between 1.3% and 15.5% of the cost of the building. The relative proportion of primary energy requirements associated with lighting was increased to 47%. Thus, since lighting represents the largest part of electricity consumption, it is potentially a relevant field for energy savings. Daylight supplies sufficient illuminance levels at location of use. In the case of an office building such a return on investment related to day lighting still needs to be demonstrated in order to become attractive both to investors and operators. A case study of buildings in the tropics was studied by **Rizki et al. (2016)** for understanding design optimization for window size, orientation, and wall reflectance with regard to various daylight metrics and lighting energy demand. Most studies were conducted for locations with high latitude, where the sun is located most of the time either at the South or at the North part of the sky hemisphere, which is not the case in the tropics. Therefore, this article presents a simulation study to investigate the influence of window-to-wall ratio (WWR), wall reflectance, and window orientation on various daylight metrics and lighting energy demand in simple buildings located in the tropical climate. An optimum window-to-wall ratio (WWR) is believed to be able in yielding significant energy savings for heating, cooling and lighting demand in buildings. It is noticed that as more efficient technologies are employed in buildings, the influence of WWR on the building energy performance tends to become lower.

5 METHODOLOGY

Two buildings namely, Campus Main building and Administrative buildings comprising of two parts (Main administrative building and FERE building) are taken for the evaluation of lighting energy performance out using simulation tools – REVIT Architecture and eQUEST. The work methodology involves comprises of the following;

- Collection of weather data for whole year of 2014
- Architectural Drawings of Building plan and elevation
- Building Materials used in the construction of the buildings
- Building Occupancy, Lighting, Equipment details
- Lighting Energy performance of the building through simulation using Revit Architecture and eQUEST software.
- Conducting artificial lighting design studies.
- Analyzing the results obtained and data interpreted.

5.1 Weather Data

June was the hottest month of the year 2014 with an average temperature of 40°C while the lowest average temperature was 18°C in the month of February. The variation of maximum temperature is 25%. The variation of minimum temperature is 28%. Figure 1 shows the maximum and minimum outdoor temperature for the year 2014 in College of Engineering- Guindy Campus.
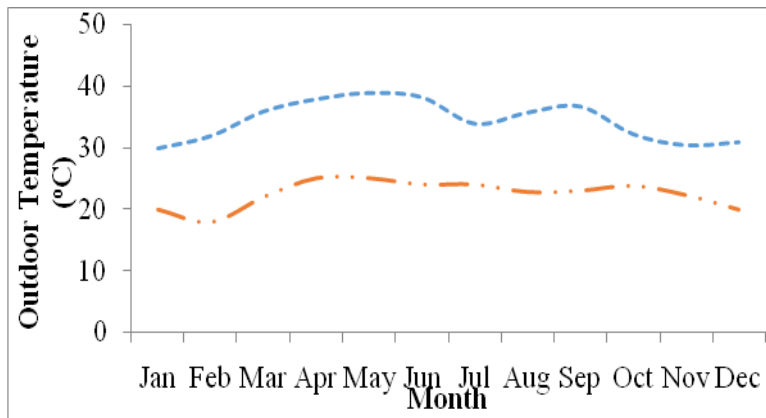
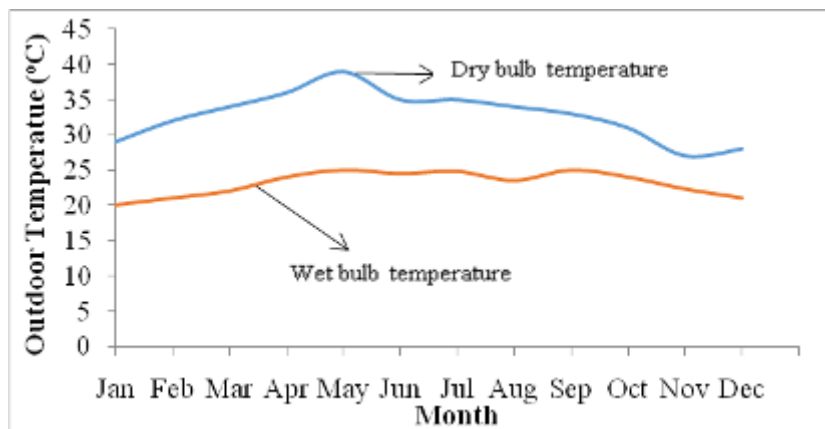**Fig. 1. Variation of maximum and minimum outdoor temperature**

Fig. 2. Variation of dry and wet bulb outdoor temperature

Outdoor Humidity is lowest at 55% during May and highest at 70% during November 2014. Figure 3 shows the variation of monthly outdoor relative humidity for year 2014 in College of Engineering- Guindy Campus.
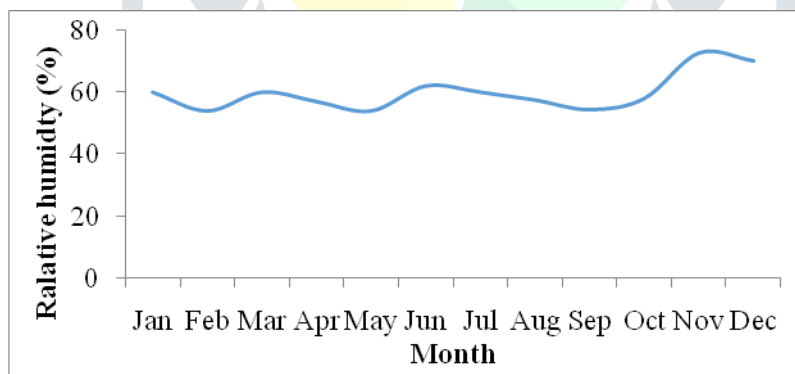

Fig. 3. Variation of outdoor relative humidity

The maximum wind speed is at 9 m/s during July and minimum wind speed of 0.4 m/s during October 2014. Figure 4 shows the variation of monthly wind speed for the year 2014 in College of Engineering- Guindy Campus.
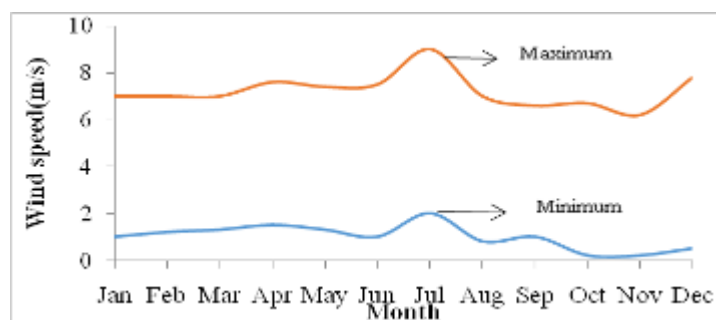
Fig. 4. Variation of maximum and minimum wind speed

5.2 Building Information

The case study buildings comprising of the Main Building and the Administrative buildings are located in the tropical climate of Chennai on latitude of 13°05'24"N and longitude 80°16'12"E at an altitude of 8 meters from the mean sea level. While the Main Building is one large building built in the vernacular style of architecture, the Administrative building comprises of two blocks namely University Administrative Building (UAB) and Fundamental Engineering and Research Establishment (FERE) building which are built in the contemporary style of architecture.

5.2.1 Main Building

For the purpose of analysis, the College of Engineering - Guindy Campus, Main Building is taken. Built in 1920, the building features many passive strategies to cater to the tropical climate. Built in the vernacular style of architecture, the longer axis of the building is oriented towards North-South direction.

5.2.1a. Building drawings

Figures 5(a) and 5(b) show the ground and first floor plan of the Main Building respectively.
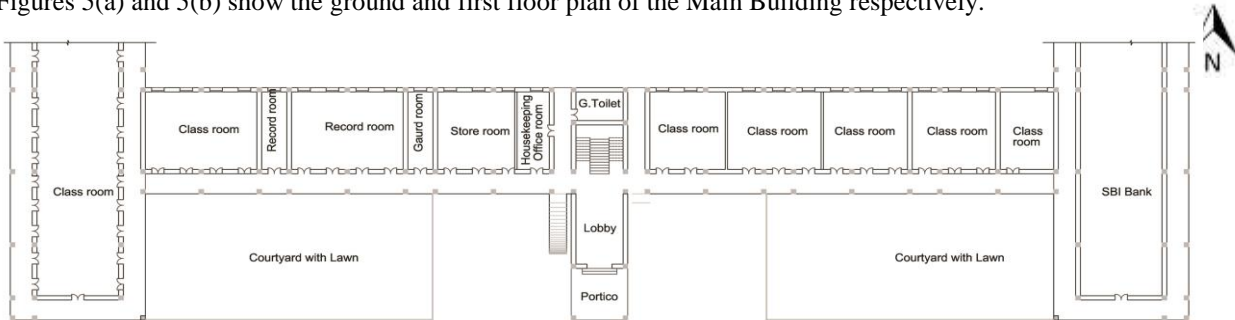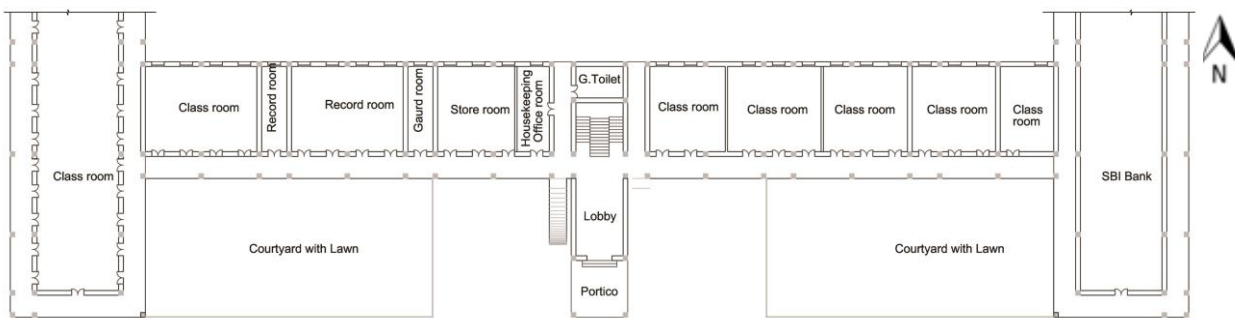

Fig. 5(a) Ground floor plan

Fig. 5(b) First floor plan

5.2.1b. Main Building Space Summary

The building use spaces are classified into eight major zones comprising of (1) Class rooms (2) Bank (3) Drawing halls (4) Lobby (5) Restrooms (6) Conference Room (7) Computer room (8) All others. Total carpet area of the building is 3300 sq.m and the plinth area is 3413.2sq.m. On the ground floor, 86.9% of the total area is naturally ventilated and the remaining areas are air-conditioned. In first floor 84.4% of total first floor area is naturally ventilated. Table 1 gives the space summary of the building. Table 2 gives a brief about the building materials used in the construction of the building.

Table 1 Main Building Space allocation

Air Conditioned		Non Air conditioned	
Building Use	**Area (sq.m.)**	**Building Use**	**Area (sq.m.)**
Office room (Executive)	99	Drawing hall	666
Bank	222	Office(General)	284
Conference hall	67	Storage	180
Computer room	123	Class room	338
-	-	Rest room	79
-	-	Others	1068
Total area	511	**Total area**	2686

Table 2 Building Materials used for construction

Component	Building Material
Wall	Brickwork with lime mortar
Window	Wooden frames with clear glass(1.2m x 1.2m)
Door	Wooden doors 1.2 m wide Ground floor height- 4 m First floor – 2.7 m
Wall finishes	Exterior-Open brickwork system, Interior-Cement plastering
Floor finish	0.6 m x 0.6 m vitrified tiles
Roof	Wooden rafter, Steel beams, Madras Terrace slab

5.2.1c. Window Wall Ratio

Table 3 shows the calculation of window wall ratio of Main building.

Table 3 Calculation of window wall ratio

Floor	Room Type	Wall Area (m^2)	Window Area (m^2)	Window Wall Ratio
Ground floor	Classroom I	71.28	4.86	0.07
	Classroom II	59.4	3.24	0.05
	Classroom III	59.4	4.86	0.08
	Classroom IV	59.4	5.94	0.1
	Classroom V	37.62	1.62	0.04
First floor	Classroom VI	39.6	1.62	0.04
	Classroom VII	41.31	4.86	0.12
	Office	76.5	5.76	0.08

5.2.2. Administrative Building

   The Administrative Building consists of two building blocks namely the University Administrative Building (UAB), built in the year 1990 and Fundamental Engineering and Research Establishment (FERE) Building built in the year 1975. The UAB is oriented with its longer axis along the East-West axis, while the FERE building is oriented along the North- South direction. The energy performance of both orientations is to be compared.

Table 4 shows the occupancy in the University Building and FERE Building on various levels.

Table 4 Occupancy of University Building and F.E.R.E Building

Level	Occupancy(person)	
	University Building(VC)	F.E.R.E Building
Ground floor	21	66
First floor	27	74
Second floor	11	70

The longer axis of the University Building is East oriented and the FERE building is North oriented making them perpendicular to one another. The University Building is exposed to intense Eastern and Western Sun, whereas only the shorter faces of the FERE building is subjected to Eastern and Western sun. Both the buildings are surrounded by large number of trees which casts good shade to all sides of both the buildings.

5.2.2a. Building drawings

Figures 6(a), 6(b) and 6(c) show the floor plans of the University Building. Figure 7(a), 7(b) and 7(c) shows the Floor Plans of the FERE building. Figures 8(a) and 8(b) show the front East elevation of the University Building and North elevation of the Fundamental Engineering and Research Establishment (FERE) Building respectively.
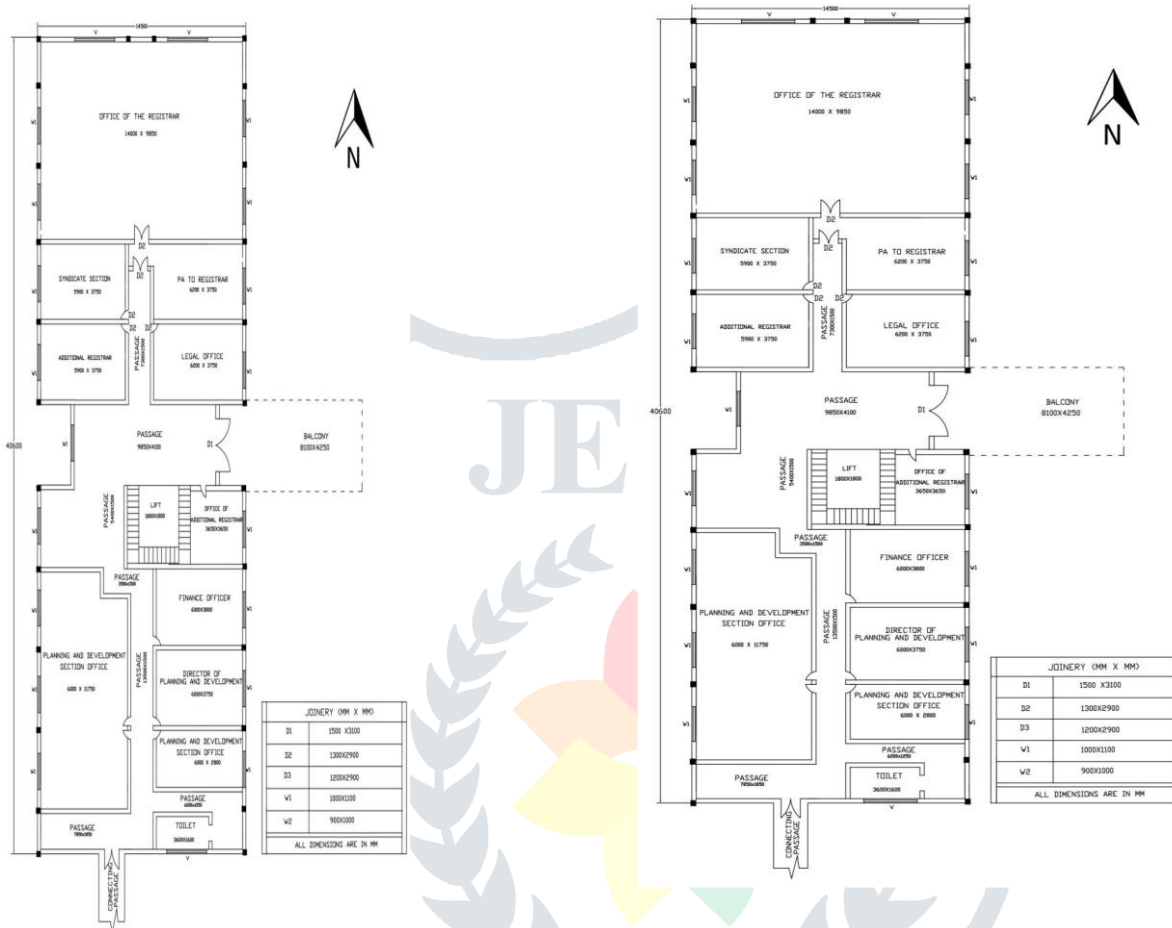
Fig. 6(a). Ground floor Plan of University Building   Fig. 6(b). First floor Plan of University Building
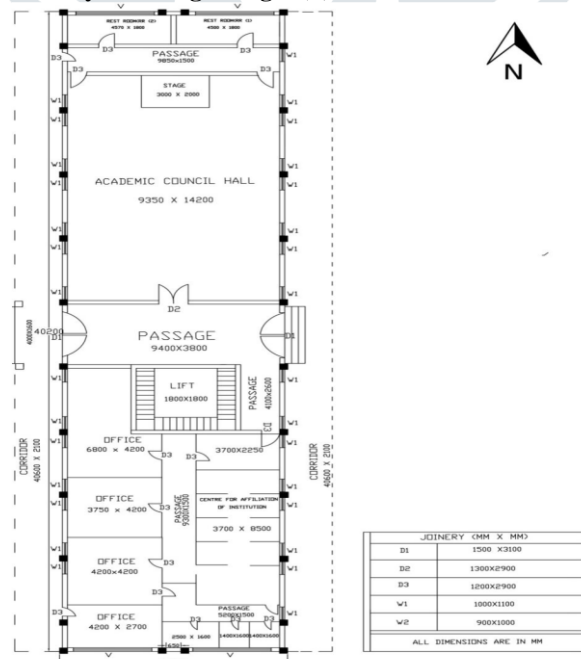
Fig. 6(c). Second floor Plan of University Building

Fig. 7(a). Ground floor Plan of FERE Building
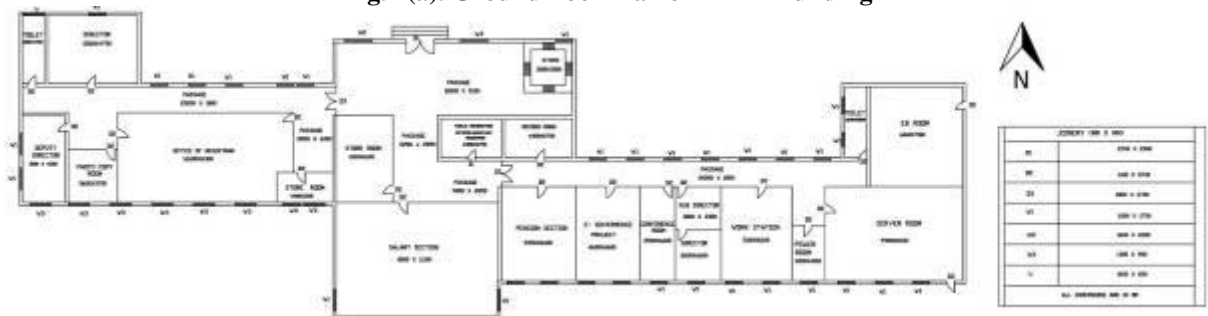
Fig. 7(b). First floor Plan of FERE Building
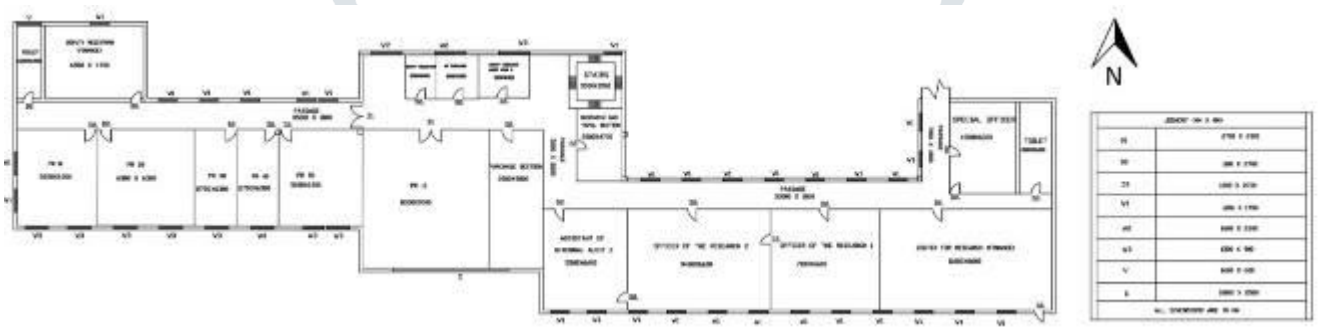
Fig. 7(c). Second floor Plan of FERE Building

Fig. 8(a). Front-east elevation of the University Building.

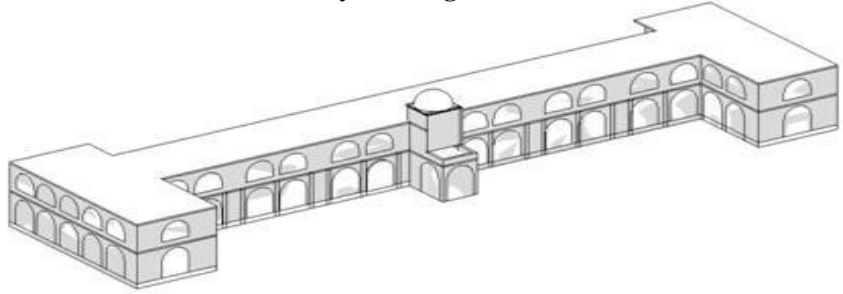**Fig. 8(b). North elevation of the FERE Building.**

Fig. 9(a). 3D model of the building

Fig. 9(b). Rendered image from REVIT software

Fig. 9(c). Western elevation

Fig. 9(d). Southern elevation

Fig. 9(e). Eastern view (Ground Floor)

Fig. 9(f). South Eastern view (First Floor)

5.2.2b. Area Details

The details of the plot area, plinth area and carpet area of the administrative buildings is as mentioned in Table 5.

Table 5 Area details of the Administrative Building

S.No	Detail	Area
1.	Plot area	17,140 m^2
2.	Plinth area	1256 m^2
3.	Built-up area	3754 m^2
4.	Air conditioned area	2005.4 m^2

The Administrative building comprises of three floor levels. The carpet area of each floor of both the buildings is mentioned in Table 6.

Table 6 Carpet area of Administrative Building

Level	Carpet area of Administrative Building	
	University Building(m^2)	FERE Building(m^2)
Ground level	393	863
First level	590	801
Second level	590	801

5.2.2c. Materials

The University Administrative building and the FERE building are built in the contemporary style of architecture using modern building materials as shown in Table 7

Table 7 Materials used in Administrative building

Component	Material	
	University Building	**F.E.R.E. building**
Wall	Brick	Brick
Window	Wooden	Wooden
Door	Wooden doors	Wooden doors
Floor	Mosaic and tiles	Mosaic
Roof	Concrete	Concrete

5.3 Building model

The software used for energy analysis of the building are REVIT Architecture 2013 and eQUEST. Using the CAD drawing as the base, the plans are extruded to 3D model using Revit software as shown in Figure 9(a). After extruding the building, Revit's rendering engine is used to make a more realistic image. This is accomplished by using the premade model, wall, floor, etc. The rendered image from REVIT software is shown in Figure 9(b) which is closely resembles the building. Figures 9(c) and 9(d) shows the view of the building along Western and Southern directions. Figure 9(e) shows the Eastern view on the Ground floor. Figure 9(f) shows the South Eastern view on the First floor.

5.3.1 Building zones

The building is divided into seven zones depending upon the usage of rooms, as shown in table 8.

Table 8 shows the various zone details of the Main building.

Zone	Usage	Nos	Occupancy
I	Classroom	7	420
II	Drawing Hall	3	360
III	Computer Room	1	40
IV	Office Room	1	40
V	Conference Hall	1	40
VI	Bank	1	100
VII	Dean Room	1	3

5.3.2 Building operations and scheduling

This includes information about the occupancy schedule (times, days of the week, and seasonal variations), occupied indoor thermostat set points, HVAC and internal equipment operations schedules. eQUEST defaults operations schedule information based on building type.

Figure 10(a) shows the Occupancy scheduling of the seven zones in the main building. Classrooms are both day-loaded and non-day loaded. Figure 10(b) shows the lighting schedule of seven zones in the main building.
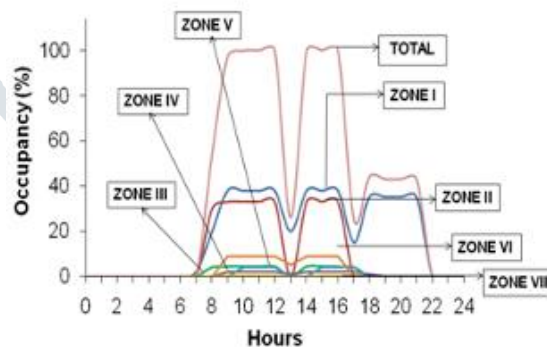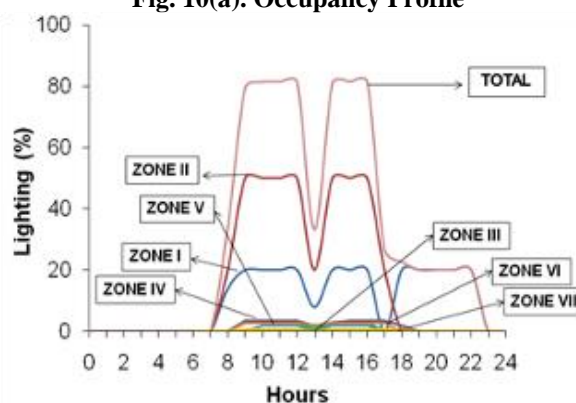

Fig. 10(a). Occupancy Profile

Fig. 10(b). Lighting Profile

Description of zones for University Administrative Building and FERE building is given in Annexure 1.

5.4 Artificial Lighting Design Study

When planning a lighting installation, it is necessary to perform a series of calculations. In general, these refer to the exact illuminance levels in specific parts of the space and the number of luminaires required for a room space. The utilisation factor describes the portion of luminous flux emitted by the light sources, which falls on the working plane after interaction with luminaires and room surfaces. It is derived from the geometry of the space, the reflectance of the room surfaces and the efficiency and the distribution characteristics of the luminaires used.

5.4.1 Main Building

Lighting Design- as per SP: 41 (S&T) - 1987

➢ Number of luminaires required $= \dfrac{E \times A}{\mu \times D \times \varphi}$

Where, E – Illuminance required, lux

A – Floor area of the room; μ - Coefficient of utilization

D – Maintenance factor; Φ – Output in lumens

➢ Coefficient of utilization is found from room index value.

Room index $= [(L \times W)] / (L+W)h_m$

➢ Height of workplane is assumed to be 0.75 m.

➢ Mounting height above the workplane, $h_m = 3.35-0.75 = 2.6$ m (mounted),

$= 3.96-1.07-0.75 = 2.6$ m (suspension)

➢ Luminaire used is two lamp aluminium troffer with louvers. It comes under direct lighting category. Luminaires should be placed parallel to long wall.

➢ Spacing of luminaires = 0.8H=0.8 x 3.6 = 2.9 m

➢ Initial lumen output of lamps = 2440 lumen

➢ Maintenance factor = 0.75 good;

➢ Reflectance: Wall -0.5,Ceiling – 0.8, Floor – 0.1

By using the standard coefficient of utilization and illuminance value the required number of luminaires is found out and compared with the original number of luminaires provided in the site.

5.4.2. Artificial Lighting Studies on Administrative Buildings

Room index $= [(L \times W)] / (L+W)h_m$

Height of workplane is assumed to be 0.75 m.

Mounting height above the workplane $= 3.66-0.75 = 2.9$ m (without false ceiling)

$= 3.35-0.75 = 2.6$ m (with false ceiling)

Luminaire used is two lamp aluminium troffer with louvers. It comes under direct lighting category.

Required illuminance for the rooms = 300 lux

Initial lumen output of lamps = 2440 lumen

Maintenance factor = 0.75good

Reflectance = Wall -0.5; Ceiling – 0.8; Floor – 0.1

Luminaires should be placed parallel to long wall.

6.0. RESULTS AND DISCUSSIONS

The Main building and Administrative Building including the University Building and Fundamental Engineering and Research Establishment (FERE) Building of Anna University are selected for energy performance study. Once the modelling and calculations are completed, energy analysis of the building is done in Revit and eQUEST software to assess Electricity Consumption and Peak demand requirement of the building. Artificial lighting study is also done to check whether the provided lighting complies with the Indian Standards. The results obtained based on the above is discussed as follows.

6.1. REVIT ANALYSIS RESULTS

The buildings are analysed by Revit software and results are drawn out. In main building the monthly Electricity consumption is 40% more in summer months as compared to winter months. Demand is 10% more in summer months as compared to winter months in all the buildings. Figure 11(a) shows the monthly Electricity Consumption of the buildings. Electricity consumption is 40% more in summer months as compared to winter months in the main building. Figure 11(b) shows the monthly peak electricity demand of the buildings. Demand is 10% more in summer months as compared to winter months in all the buildings.
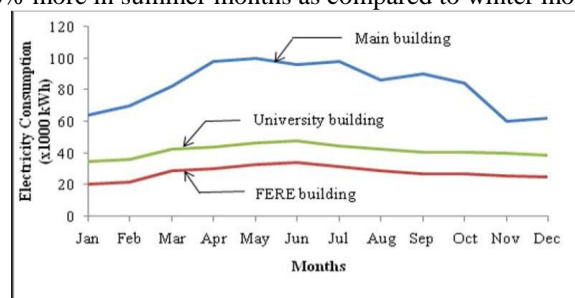

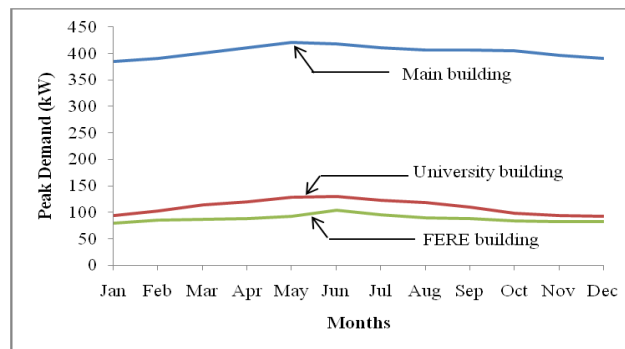**Fig. 11(a). Monthly Electricity Consumption**

Fig. 11(b). Monthly Peak Demand

6.2. eQUEST Analysis Results

Next step is to analyze the building using eQUEST software.

6.3. Main building

Figure 12(a) shows the monthly energy consumption of the building. It is found that Lighting consumes more energy than miscellaneous equipment and mechanical fans. About 17 % of total annual energy consumption is for lighting of the building. Monthly peak demand is higher in the month of May and least in the month of January 2014. Lighting accounts for higher annual peak demand of electricity consumption than mechanical fans and miscellaneous equipments. Figure 12(b) shows the monthly peak demand of the building.
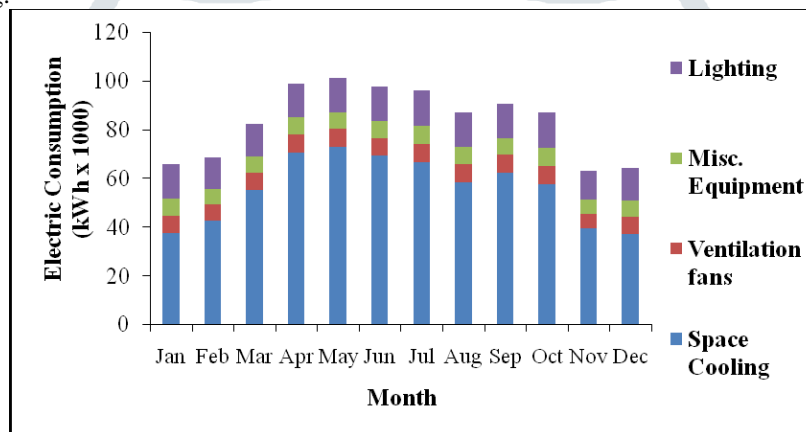
Fig. 12(a). Monthly Energy Consumption by enduse – Main building
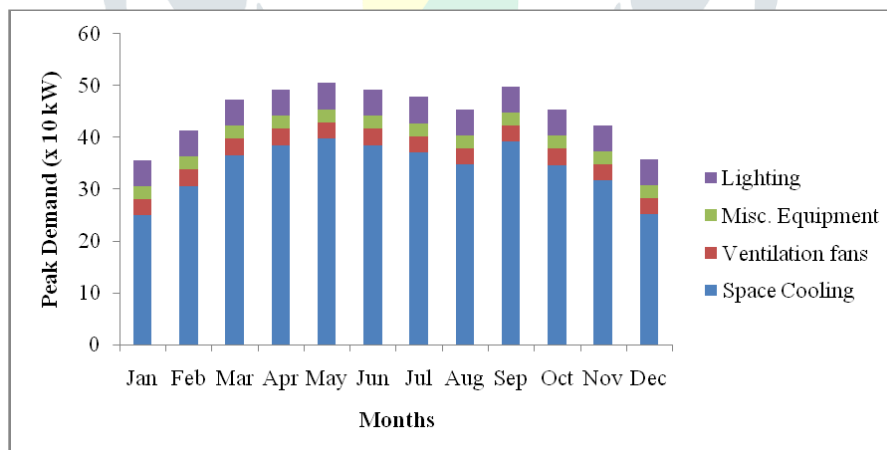
Fig. 12(b). Monthly Peak Demand by enduse – Main building

6.4. Administrative building

University building consumes more energy when compared to the FERE building. With respect to energy consumption for lighting there is not much difference in summer as well as winter months. Figure 13(a) shows the electric consumption for Area Lighting and Ventilation fans of the Administrative buildings (University Administrative Building and FERE building). Annual Electricity Consumption for the Administrative building (University building and FERE building) is shown in Figure 13(b). Energy Consumption for Lighting and Miscellaneous equipment is 61% and 54% respectively, higher in University building when compared to FERE building. Mechanical fans' utilization is similar for both, the University Administrative and FERE building. Peak Demand for lighting of University building is higher than the FERE building. Lighting contributes more to Peak demand compared to Mechanical fans. Figures 14(a) and 14(b) respectively show the Monthly Peak Demand and Annual Peak Demand for Mechanical fans and Area Lighting in the Administrative buildings. It is found that the Annual Peak Demand for

Lighting is 15% less in University building as compared to FERE building. Consumption due to Miscellaneous Equipment and Mechanical fans is 40% higher in University building than FERE building.
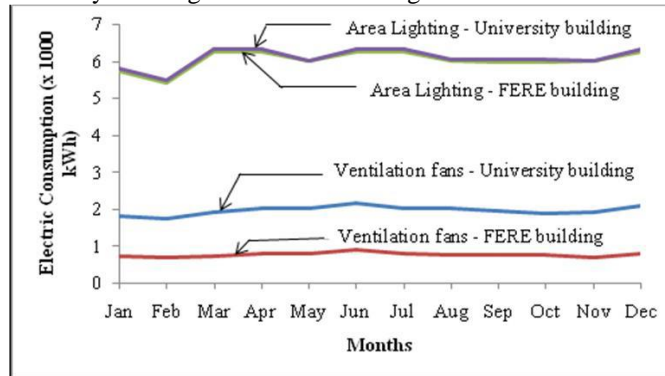

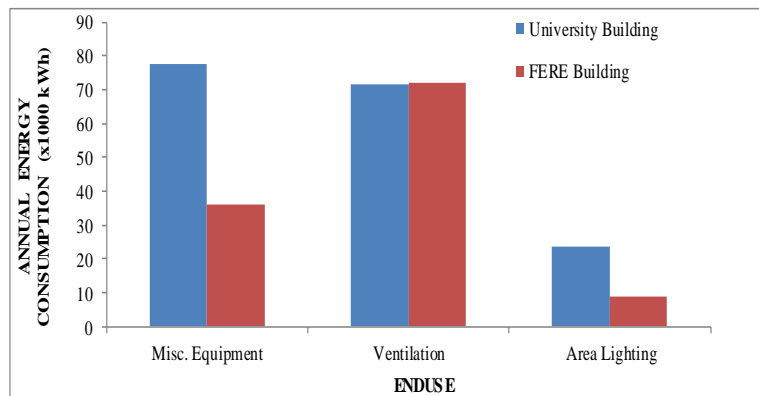**Fig. 13(a). Electric Consumption for Area Lighting and Ventilation fans**

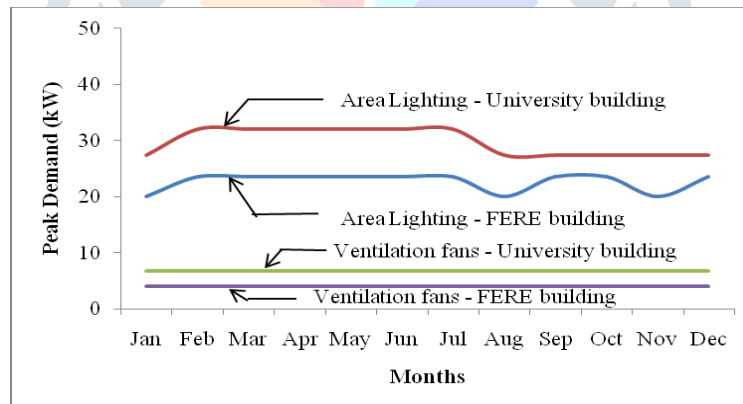**Fig. 13(b). Annual Energy Consumption of Administrative building.**

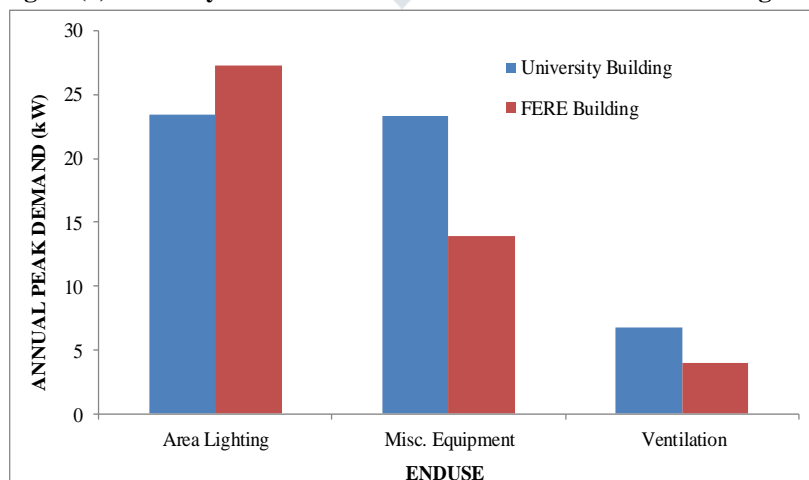**Fig. 14(a). Monthly Peak Demand for Ventilation fans and Area Lighting**

Fig. 14(b). Annual Peak Demand for Administrative building

6.5. ARTIFICIAL LIGHTING STUDY RESULTS
6.5.1. Main building

In the drawing hall, the number of luminaires is insufficient. In all the other rooms, sufficient luminaires are provided. Figures 15(a) and (b) show the Coefficient of Utilization vs Room index plot for single lamp and two lamp aluminium troffer respectively. In the conference hall, coefficient of utilization value is found to be higher than that of the required amount. In administrative office, the coefficient of utilization of luminaires is sufficient to provide enough illuminance. Figure 15(c) shows the comparison of required versus available illuminance in the Main building.
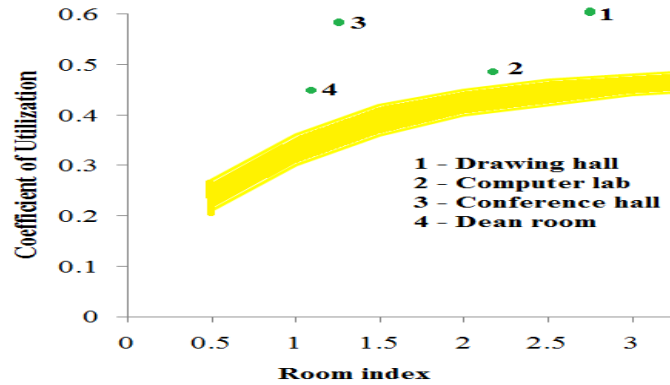
Fig. 15(a). Coefficient of Utilization vs Room index – Single lamp unit
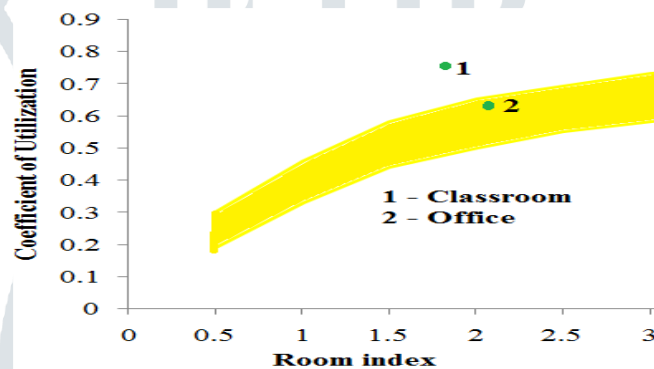
Fig. 15(b). Coefficient of Utilization vs Room index – Two lamp Aluminium troffer
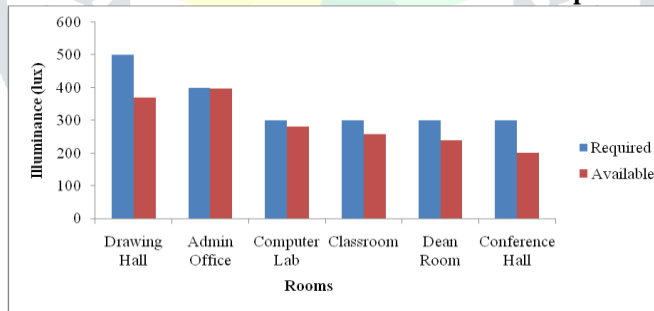

Fig. 15(c). Comparison of required and available illuminance in the Main building.

Illuminance required is higher in drawing hall since it involves difficult visual task. Illuminance provided in drawing hall is 26 % lesser than that required. This is accomplished with the help of natural lighting with a daylight factor of 3%. In Conference hall, illuminance provided is much lesser than that of required illuminance. In admin office, sufficient illuminance is provided.

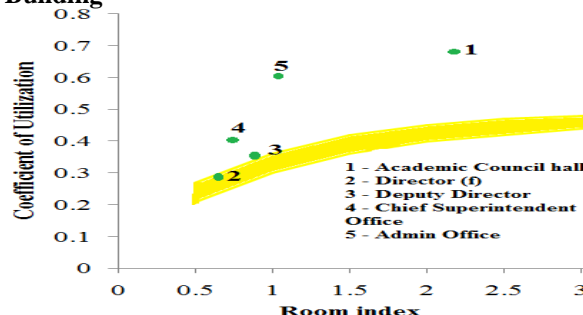#### 6.5.2. University Administrative Building

Fig. 16(a). Coefficient of Utilization vs Room index – Ground floor

Figures 16(a), (b) and (c) show the Coefficient of Utilization versus Room index plot for ground, first and second floor of the University Administrative Building respectively. In the Syndicate Hall, Director (Finance) room, Office of Additional Registrar rooms, sufficient lighting is provided. In Deputy Director's room and Director's room sufficient lighting is provided. Figures 17(a), (b) and (c) show the comparison of required and available illuminance of ground, first and second floor of the university building respectively.
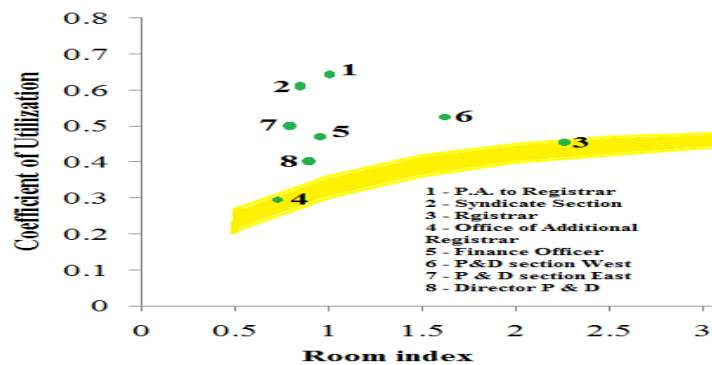
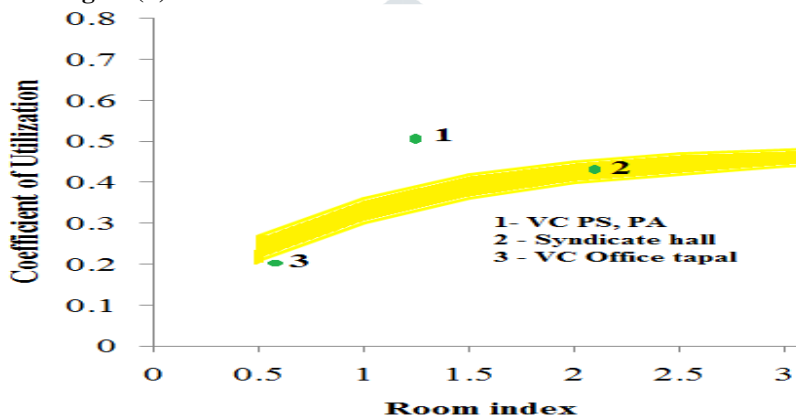**Fig. 16(b). Coefficient of Utilization vs Room index – First floor**

Fig.16(c). Coefficient of Utilization vs Room index – Second floor
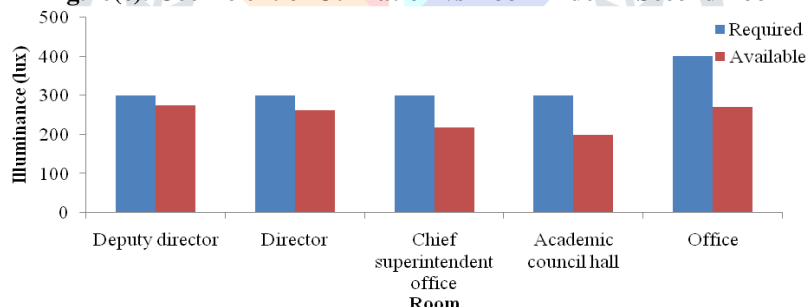

Fig. 17(a). Comparison of Required and available Illuminance in the Ground floor- University building.
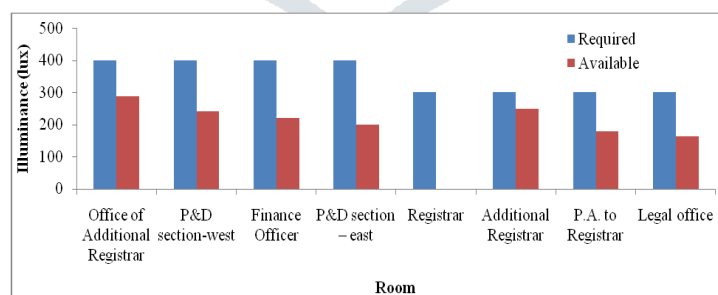

Fig. 17(b). Comparison of Required and available Illuminance in the First floor- University building.
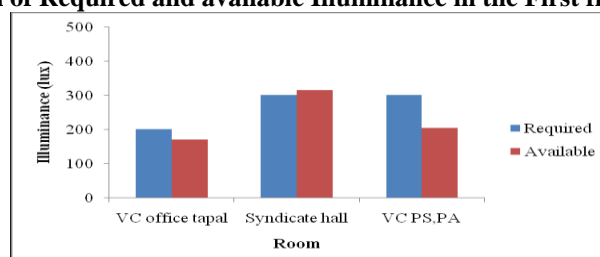

Fig. 17(c). Comparison of Required and available Illuminance in the Second floor- University building.

In Deputy Director's room and Director's room, sufficient lighting is provided. In executive rooms, sufficient lighting is provided. In office rooms, the artificial lighting provided is lesser by upto 50%. In the syndicate hall, the provided illuminance is found to be sufficient for efficient lighting. In other office rooms it is found to be 33% lesser than what is needed.

6.5.3. FERE building

Figures 18(a), (b) and (c) show the Coefficient of Utilization versus Room index plot for ground, first and second floor of FERE building respectively. Artificial Lighting provided can be limited to the level of requirement as it can be seen that the Coefficient of Utilization is much higher than the requirement. In some of the zones, natural light contributes significantly with a daylight factor of 9%. Figures 19(a), (b) and (c) show the comparison of required and available illuminance of ground, first and second floor of FERE building respectively.
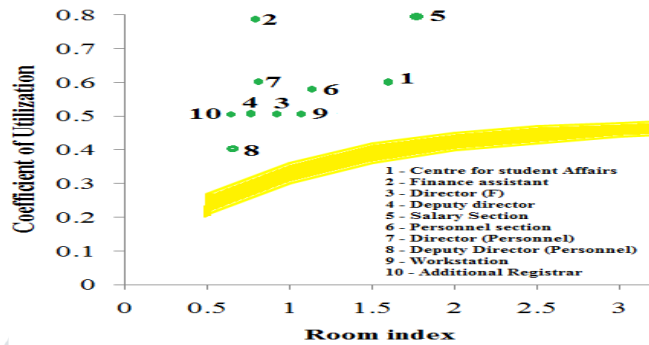

Fig. 18(a). Coefficient of Utilization vs Room index –Ground floor FERE building.
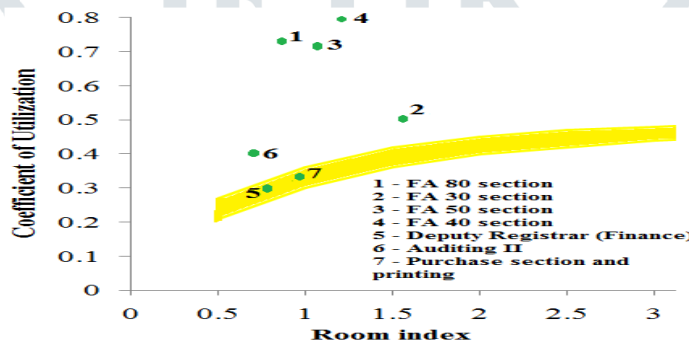

Fig. 18(b). Coefficient of Utilization vs Room index –First floor FERE building.
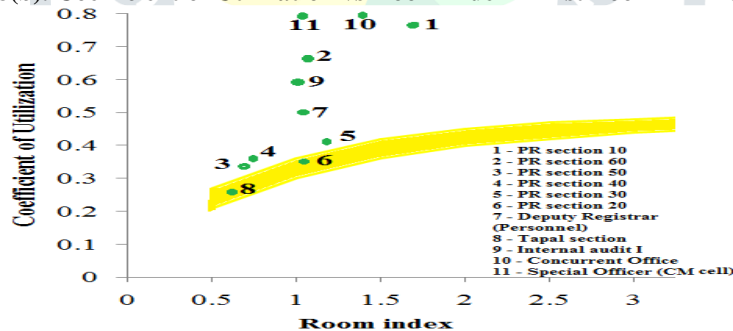

Fig. 18(c). Coefficient of Utilization vs Room index –Second floor FERE building
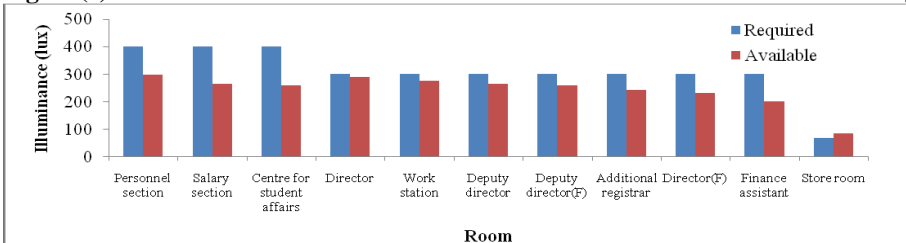

Fig. 19(a). Comparison of Required and available Illuminance in the Ground floor- FERE building
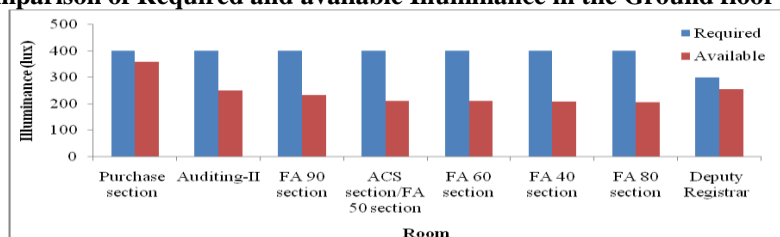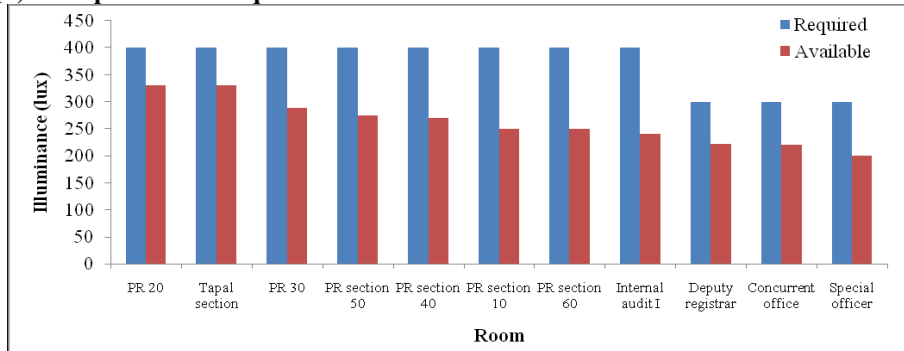
Fig. 19(b). Comparison of Required and available illuminance in the First floor- FERE building.

Fig. 19(c). Comparison of Required and available Illuminance in the Second floor- FERE building.

In Office rooms (executive), the provided illuminance is found to be sufficient. But in other regular office rooms, on the first floor, illuminance provided by artificial lighting is 40% lower than that required. But sufficient lighting is provided by natural lighting with a daylight factor of 9%. In the Public Relations section, the illuminance provided is 35% lesser than that needed. In executive office rooms, illuminance is 14% lesser than that of required illuminance.

6.5.4. COMPARISON BETWEEN BUILDINGS

Energy Consumption of University building is 50% higher than that of FERE building, due to orientation, longer side of the University building is facing east and west direction. There is only marginal variation in the results during the summer months of May, June and July 2014. Larger variation of about 30% is seen in the winter months. Both the software results show higher energy consumption of about 35000 kWh in the summer months. Energy consumption in the main and administrative buildings are mainly for Space cooling and lighting.

7. CONCLUSION

After a wide study of different case study and analysis in lighting as per above literature and calculation, its been observed that building orientation, control systems parameters and design parameters plays a vital role in the conclusion of lighting required, the main aim was to show the best lighting system.

Orientation of the building plays a significant role in the Energy Efficiency of buildings. Since the Main building is oriented North-South longer axis, it is found that Electricity consumption is 40% more in summer months as compared to winter months. Monthly peak demand is higher in the month of May and least in the month of January for the same occupancy and equipment load. In the Drawing Halls, the numbers of luminaires are insufficient (see table 9). In the Conference hall, Coefficient of Utilization value is found to be much higher than that required. In Administrative office, the Coefficient of Utilization of luminaires is sufficient to provide enough illuminance.

The University Building consumes more energy when compared to the FERE building. In the FERE building there is only marginal variation in electricity consumption between summer and winter showing that choice of envelope building materials plays an important role in Space Cooling and Lighting energy needs. In Office rooms (executive), the provided illuminance is found to be sufficient. In general office rooms (first floor), the illuminance provided by artificial lighting is 40% lower than that required. But sufficient lighting is provided by natural lighting with a daylight factor of 9%. By using Switching Controls, the energy consumption due to Lighting can be drastically reduced.

Hence, after such comparisons, it has been observed and proved that the vernacular techniques followed while constructing the main building proves to be more energy efficient and helps in reducing the consumption of electricity, hence as per the abstract and objective the design of future buildings should consist of all parameter as per the points observed and proved to save our environment being affected by our buildings.

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