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Importance of Daylighting over Artificial Lighting

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Abstract: This paper aims to find out the contributions of the day lighting system and to reduce the artificial lighting system are simultaneously taken into account. The concept behind this is that to increase the use of day lighting by sustainable strategies in order to decrease the amount of load in artificial lighting. Different typology of the building is taken into consideration to understand the amount of light we need in different workspace. It will be understand how to reduce artificial lighting by low-light fixture and fill the gap where day lighting is not possible to reach the working space. Daylight is important in a work space to make the indoor environment comfortable to work and more productive. So finding strategies to improve the day lighting helps in improving the indoor environment. Also, low-light fixtures are also there so that energy consumption is less and according to the typology and need of the building artificial lighting can be used in places where day lighting is not available.

***Index Terms* - Daylighting, Artificial lighting, Sustainable Strategies, Simulations.**

I. Introduction

Daylighting is a practice to bring natural light inside the building to provide a better indoor light environment. Openings are there in which windows, skylights and other reflective surfaces are placed so that sunlight can provide effective natural lighting. It not only reduces electricity usage but also makes the environment healthy to work. Artificial lighting refers to any light source produce by electrical means and consumes a large amount of electricity and also dissipates waste heat into the indoor spaces hence, causes the increases of cooling load. Its sources include incandescent bulbs, halogen lamps, metal halide, fluorescent tube and compact florescent light.

This paper addresses the main aspects of day lighting over artificial lighting. We have given various ways to improve day lighting with sustainable strategies and to minimize artificial lighting which helps in reducing the overall energy consumptions. Daylighting can reduce overall energy consumption by 20% and reduce the sensible heat load on air conditioning.

II. Importance of Day Lighting over Artificial Lighting

Daylighting not only saves electricity but it also leads to light, airy architecture of great beauty. It has become a major element in energy efficient design and sustainable solar passive architecture. If day lighting is being used effectively then the decrease of cooling and lighting energy required to condition building would come true. Important factors to have day lighting are given below:

a. Daylighting increases the comfort and productivity of people living in them.

b. Daylight boosts one's mood and motivation in the work place; the work is done faster and involves more pleasure and the results are better.

c. Stress has been reduced since it creates a calmer indoor environment as it reminds people of the outdoor.

d. Maximum daylight helps to reduce monthly electricity bills by decreasing the amount of electricity spent.

III. Ways to Improve Day Lighting with Sustainable Aspects

3.1 Window orientation to maximize the benefits of day lighting

It aims at using maximum sunlight through the size and location of the window. Daylight captures diffuse light without any compromise on comfort and its functions. Depending on the nature of the room this strategy should enhance the quality of light. Discomforts are reduced by providing overhangs and by avoiding the location of windows on east and west side of the buildings.

3.2 Use of clerestories

In Egyptian architecture, this strategy has been long used. A clerestory is a series of fenestration or glass window at a top of a high section wall usually at or near the roof line. The main purpose is to admit light, fresh air, or both.

Figure 1 Clerestory

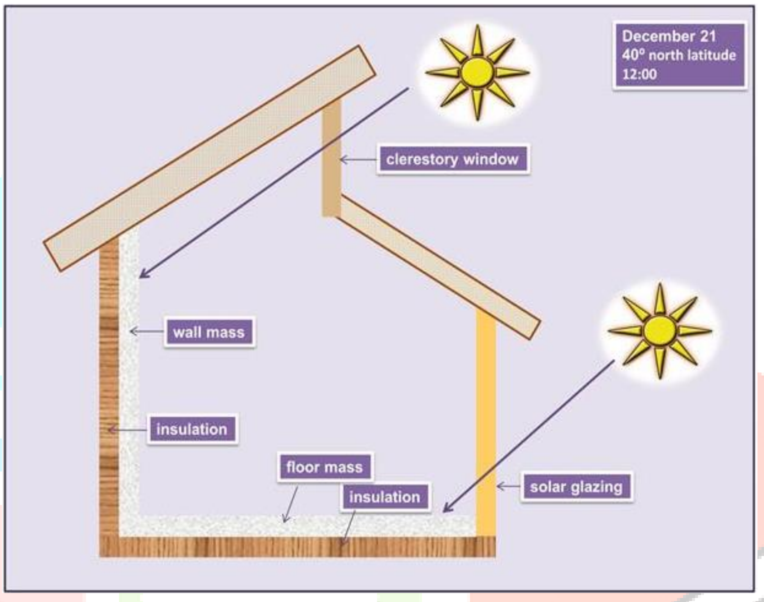

Figure 2 Showing daylight through clerestory

3.3 Light shelves

A light shelf is a horizontal day lighting system that introduce external natural light into the building interiors by reflecting the light from light shelf's reflector and indoor ceiling surface. Light shelves are installed in classrooms, office buildings and higher education facilities for day lighting. Case study: Live Building Integrated learning center Queens University in this building they have implemented this light shelves.

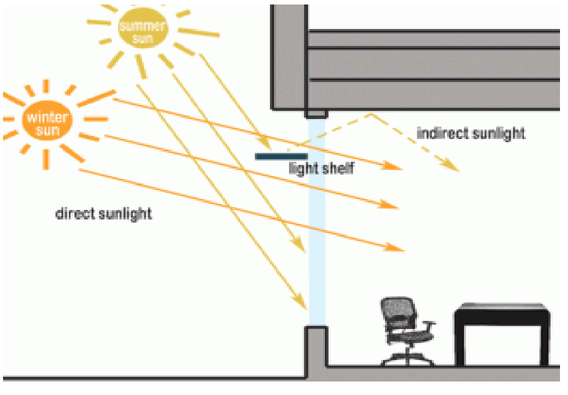

Figure 3 Light shelf

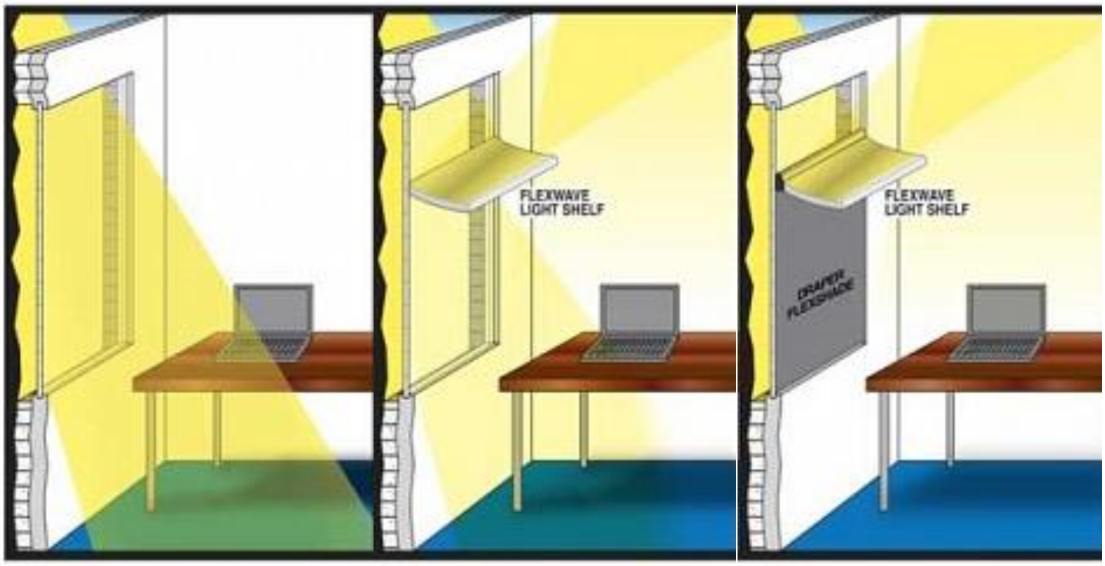

Figure 4 Showing daylight through light shelf

No window treatment	Light shelf	Light shelf + shade
Full impact of heat gain and glare from entire window area	**Reduced heat gain and glare at work surface; indirect daylight further into room**	**Best light control at work surface; indirect daylight further into room**

Table 1 Daylighting showing through light shelf

3.4 Skylights

A skylight is a light-transmitting structure that are located on the roof of a building for day lighting purposes. Skylights are installed to provide day lighting and/or ventilation. It is an energy efficiency structure for comfort and day lighting. Skylight is a source of natural light and can admit more than three times as much light as a vertical window of the same size, distributing it evenly, saving energy and improving your visual comfort levels.

3.4.1 Fixed unit skylight:

A fixed skylight is a fixed frame glazing infill (light-transmitting portion is made of glass or plastic). It is non-operable and hence the best choice for a low pitch roof where ventilation is not a consideration.

Figure 5 Fixed unit skylight

3.4.2 Operable skylight:

An operable skylight is supported by a frame and uses a hinged sash attached to it. It is within the reach of the occupants so it is also called a roof window. Roof windows are placed for attic rooms in which a cathedral ceiling is there with a little roof space. It is operable, i.e. can be opened, especially in two storey houses where heat would otherwise tend to concentrate in the upper level, which is recommended in summer conditions, which is recommended in summer conditions.

Materials - Frames have external weather-proof cladding and are typically of timber, but may be aluminium or steel are used. In cold climates, metal frames should be insulated because of the condensation they create.

Figure 6 Operable skylights

3.5 Tubular skylights

Tubular skylights have a small cross-sectional area that reduce absolute heat loss and heat gain. Sometimes called tubular day lighting devices (or TDDs), their day lighting effect relies on their ability to capture direct-beam sunlight, transmit it down a highly reflective light well and diffuse it at ceiling level around the room. Its diameters ranging from about 10 inches for residential applications to 22 inches for commercial buildings.
Materials - Made from acrylic or polycarbonate formulated to block ultraviolet rays. An aluminium tubing system is there where the dome captures and redirects light rays.

Figure 7 Tubular skylights

3.6 Courtyard planning

Courtyard is an enclosed often surrounded by rooms that is open to sky. It provides maximum daylighting and air circulation. It evolved in India during Mughal, Portuguese and European influence. In the southern states of Kerala most ancestral house have courtyard according to the vaastu shashtra.

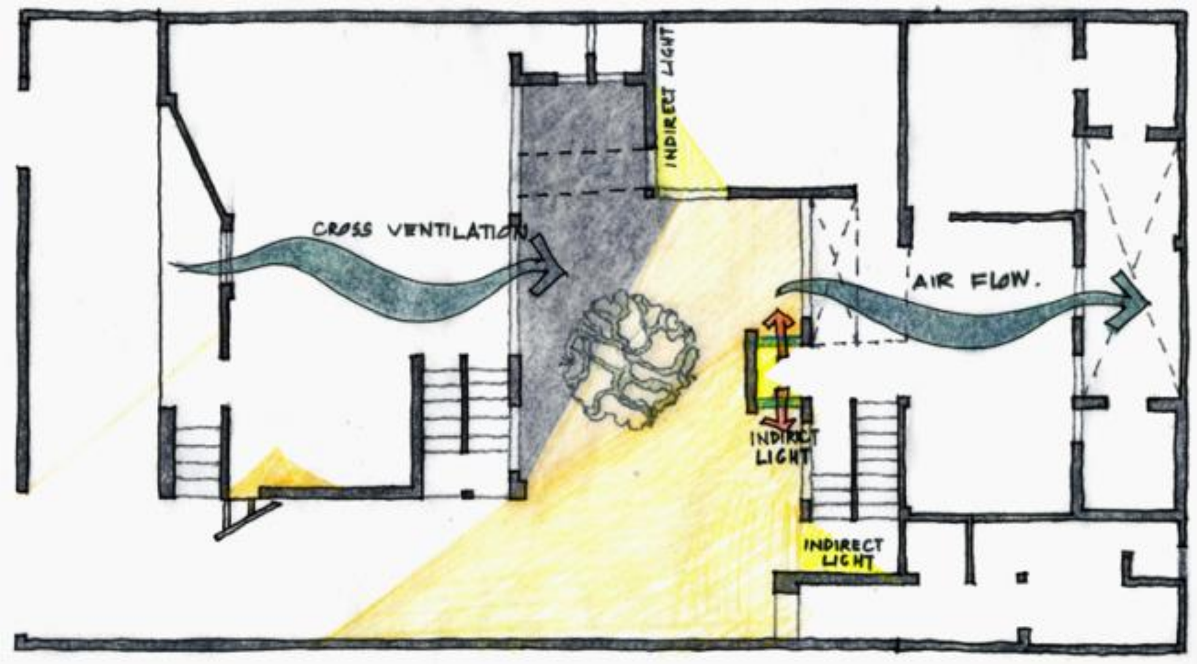

Figure 8 A courtyard planning

Figure 9 Courtyard showing daylighting

IV. WAYS TO MINIMIZE ARTIFICIAL LIGHTING:

4.1 Satisfying natural lighting will automatically reduce the use of artificial lighting:

During the planning of a building if we consider certain strategy to increase the daylighting then the need will be reduced.
Orientation of the building is an important factor to get ample amount of day lighting in the workspace.
Solar passive architecture should be taken into considerations so that the use of artificial lighting will be reduced and energy conversation can be done. Energy-efficient windows and also advance lighting design helps to scale back the requirement for artificial lighting during daytime without causing heating or cooling problems.

4.2. Replacing TRADITIONAL LAMPS with CFLs & LEDs

By replacing traditional lamps by CFLs use about 2/3 less energy, same amount of light is being given, and can last 6 to 10 times longer.

Figure 10 Traditional lamp ***Figure 11*** CFL ***Figure 12*** LED

HOW IT WORKS Tungsten filament heated to 4000 degrees Fahrenheit (2,200 degrees Celsius)	Heated gas produces ultraviolet light converted to visible light by bulb coating	Light-emitting diodes
COST PER BULB $0.50	$4.00	$25.00
LIFE SPAN 1,000 hours	8500 hours	25,000 hours
Number of 60-WATT EQUIVALENT 22 **BULBS REQUIRED TO SUPPLY 20 MILLION LUMEN-HOURS**	3	1
EQUIVALENT BRIGHTENESS: 2,600 lumens 150 watts 1,600 lumens 100 watts	32-35 watts 23-26 watts	25-28 watts 16-20 watts

Table 2 Shows the consumption of traditional lamp, CFL and LED

4.3. Installation of Occupancy/Motion Sensors to turn lights on and off

Infrared Sensors detect changes in heat patterns created by a moving person. Obstructions block motion detection and reduce its effectiveness.

Ultrasonic sensors transmit sound above the range of human hearing and monitor movement patterns.

Hybrid Occupancy Sensors utilize both passive infrared and ultrasonic technology, but are usually more expensive.

Figure 13 Infrared sensor ***Figure 14*** Ultrasonic sensor

Application	Potential Energy Cost Savings
Offices (Private)	25-50%
Offices (open areas)	20-25%
Restrooms	30-75%
Corridors	30-40%
Storage areas	45-35%
Meeting rooms	45-65%
Conference rooms	45-65%
Warehouses	50-75%

Table 3 Energy cost savings

4.4. Installation of "Lighting Controls" such as Photo Sensors or Time Clocks

Photo Sensor Controls allow fixtures to operate only when needed and monitor daylight conditions.

Time controls save energy by reducing lighting time of use through pre-programmed scheduling.

Figure 15 Photo control sensor ***Figure 16*** Time based sensor

Day Lighting Strategy	Control Type	Potential Annual Energy Savings
Window Side lighting	On/off	32%
	Stepped	44%
	Continuous dimming	56%
Sky lighting	On/off	52%
	Stepped	57%
	Continuous dimming	62%

Table 4 Potential Annual Lighting Energy Cost Savings with Day lighting Controls

V. COMPARATIVE STUDY:

5.1. Advantages of daylighting

Energy conservation - Day lighting minimize the use of artificial light source, reduces electricity and HVAC (heating, ventilation, and air conditioning) costs. Day lighting does not generate heat when controlled properly whereas electrical appliances produce high level of heat. Day lighting saves up to 75% of energy consumed in lighting buildings as well as reducing cooling costs. This leads to energy conservation.

5.2. Software analysis

This Residential building Simulations done in DIVA RHINO Software.

Room Typology	LUX Level Required	LUX Level as per Simulation
Kitchen	150	60-85
Bedroom	100	70-100
Bathroom	50	10-25
Living Room	100	75-100
Hall way	50	50
Dinning	100	90-100
Stair Case	100	50-70

Table 5 Data analysis of a residential building

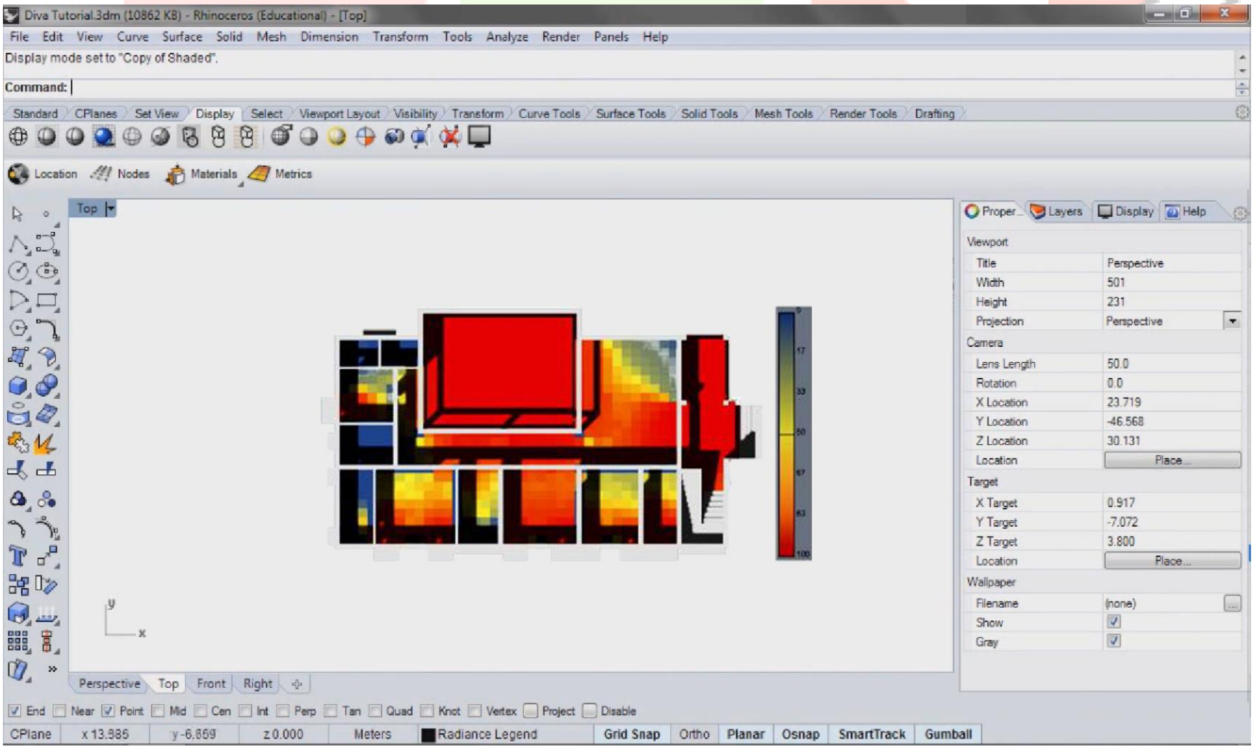

Figure 17 Interface of the diva software

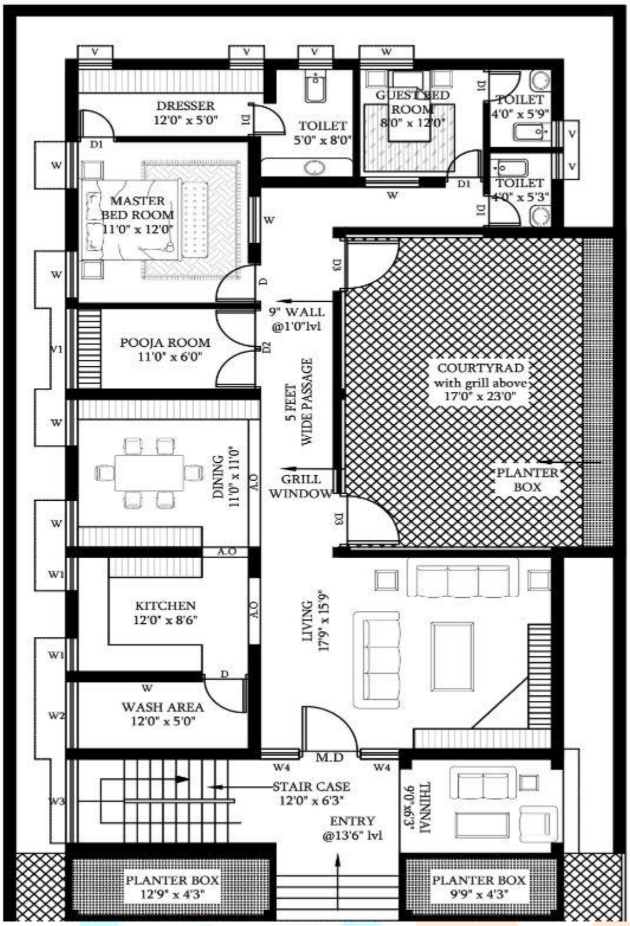

Figure 18 Residential building plan

Figure 19 Daylight analysis of the residential building

This Office building Simulation is done in DIALUX Software.

Room Typology	LUX Level Required	LUX Level as per Simulation
Work space, Entrance foyer, Reception areas	320	150-200
Store rooms, Walkways, Seminar rooms	240	100-150
Passage ways, Toilet blocks	80	10-25

Table 6 Data analysis of an office building

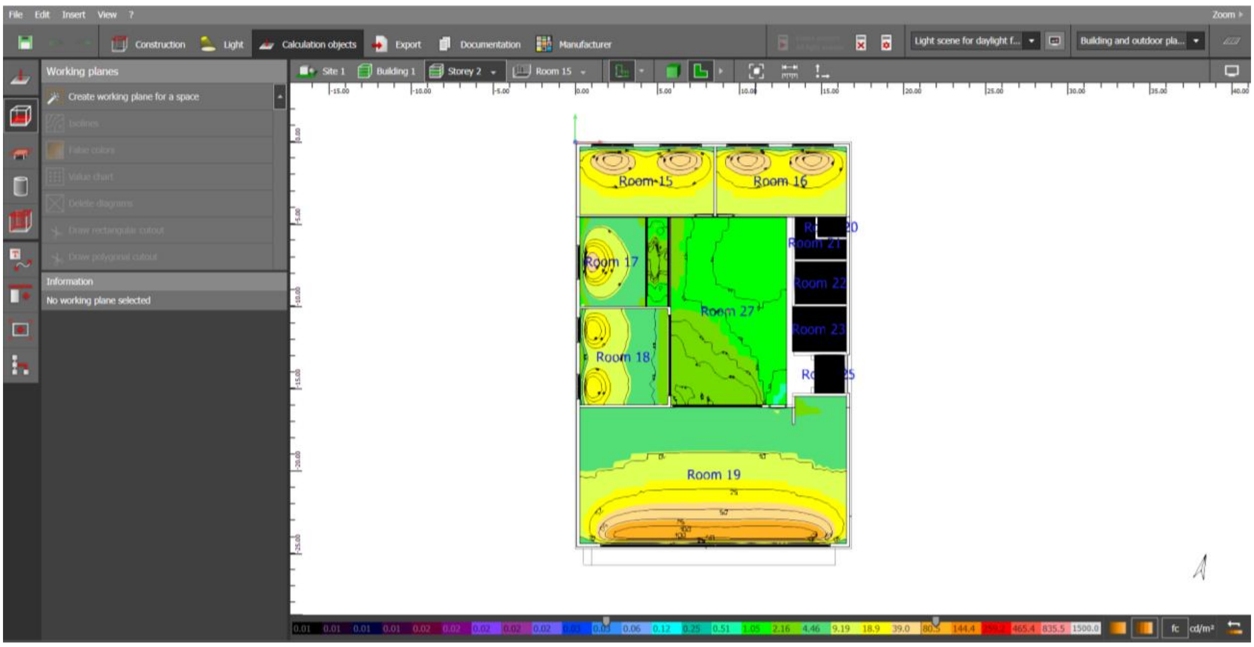

Figure 20 Interface of dialux software

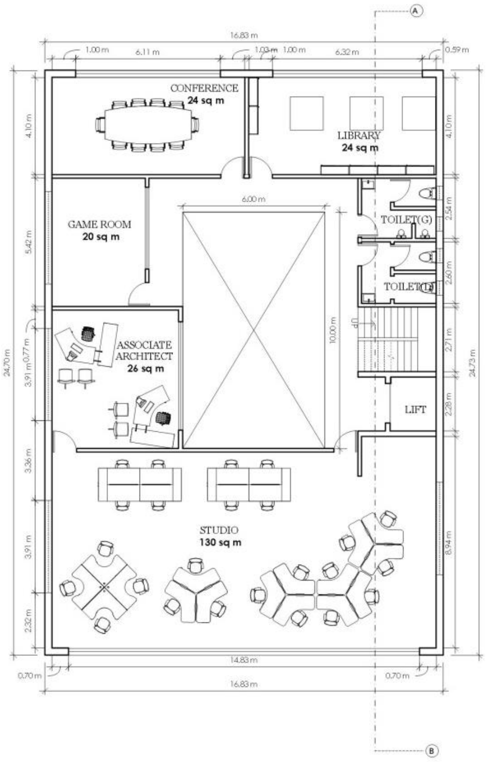

Figure 21 Office building plan

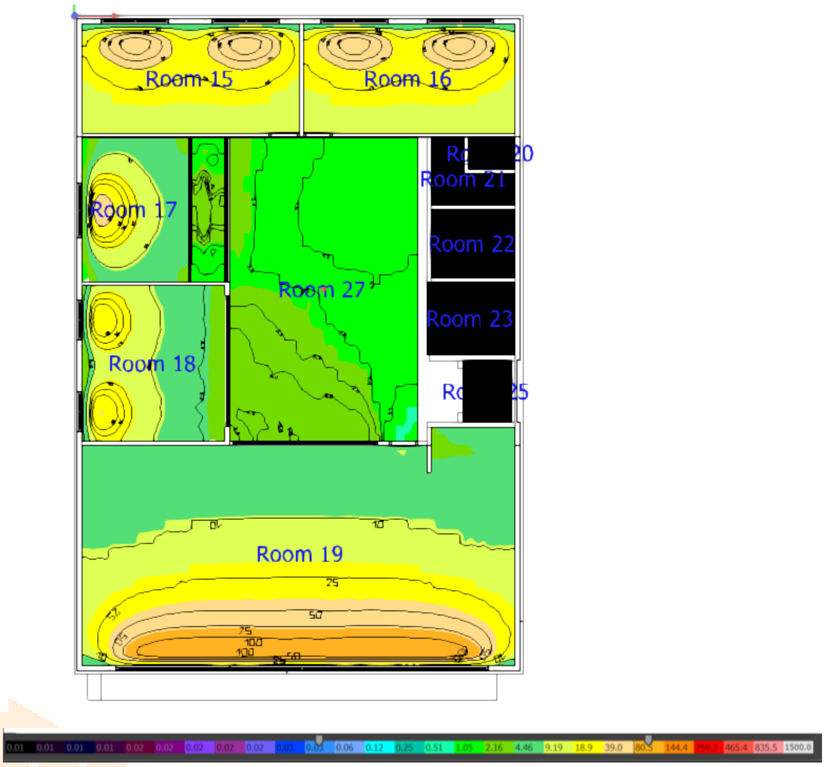

Figure 22 Daylight analysis of the office building

5.3. Which one is better for workspace and home – day lighting or artificial lighting?

According to the typology of the building daylight and natural light is determined. In office space more light is required to do work so more lighting is required. And in residential building less lighting is required as compared to office building. So sustainable strategies can be used in both to decrease the energy load of the building. As it is understand that in the residence plan courtyard planning is done so daylight is available in the building while in office plan it is understand that day lighting is covered at places where openings are there and at some areas it is not sufficient to do work. So hence we can say that in office combination of both daylight and natural light can be done so that energy is conserved. Energy efficient lighting fixtures should be used. In residential proper amount of daylight is provided by using sustainable strategies which help in energy conservation.

VI. Conclusion:

This study will provide the appropriate daylight strategies that achieve the quality of light needed in order to improve performances as well as saving electrical funds. In conclusion, this study presents a serious endeavour to apply sustainable architectural design strategies to utilize natural daylight.

The concept of sustainability has to go beyond the exclusive optimization of ranging energy performance factors which lead to a reduction of consumption and environmental impacts. It must also acknowledge the physical, physiological and psychological human needs. Sustainability calls for long-term changes through the interplay of several interconnected systems, adopting an integrated approach to architecture where a decision in one area can influence another. In this context, daylight is an intriguing aspect of design in which environmental, energetic, aesthetic, social, cultural, financial and human aspects simultaneously work together. Thus, this first study makes it possible to develop various evaluation methods that are simple to implement and provide easily workable results for the natural lighting from a quantitative and qualitative point of view.

Workplaces that are dependent on artificial light is less productive, less healthy and far less energy efficient than their natural counterparts. We should understand the value of day lighting but it doesn't mean we should neglect artificial lighting.

Combination of artificial and natural lighting are being used in most energy efficient building.

Day lighting cannot completely replace artificial lighting in workplace. Instead, using artificial light to "fill in the gaps" in the workplace makes the transition to an energy efficient lighting system easier.

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