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Feasibility Study of Tubular Daylighting Device for an Office Building at Pune

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Abstract:
This paper depends on the reason that energy streamlining is conceivable in places of business through plan of daylighting the inspiration for the review was brought into the world of the way that in India, among all structure typologies, business structures burn-through the most extreme energy. This energy utilization is mostly for cooling of the building and lighting the inside spaces. Cooling and illuminating spaces creates heat in and around the structure, which again expands the cooling load. Out of the all-out electrical energy needed in the structure, around 20- 40% is utilized for lighting purposes. Not withstanding accessibility of sunlight during the functioning hours, fake lighting is utilized in workplaces that have tremendous inward spaces with enormous ranges. This paper points at understanding the elements identified with sunlight infiltration into place of business in various circumstances and creating rules for accomplishing greatest sunshine infiltration in enormous spaces.

Keywords: Daylighting, Tubular daylighting system, Luminance, Illuminance

INTRODUCTION

Daylighting has been an essential piece of engineering and Architectural considerations. Light illuminates and serves a lot of purpose in a building; hence daylighting is one of the conditions taken into consideration during planning and designing. To create a quality of life in the living environment, architects must design structures that have illumination by daylighting in spaces that are natural light. Therefore, natural daylighting is essential in planning considering the visual perception and lifestyle of people influenced by daylight which in turn affects their behaviour, working patterns, emotions, and so on. Moreover, daylight plays an imperative role in achieving a sustainable and healthy living environment.

Furthermore, sustainable energy consumption in buildings has wilt relevant, and there has been an increased interest in saving energy over the last couple of decades. This quest together with growing snooping for the environment has spurred the growth of daylight Technology in the field of Sustainable Architecture Several researches in the past focused on daylighting in buildings. One of the prominent researches on daylighting cantered on the perception of daylight as a function that increases human activity performance and repletion within indoor spaces Thus, using daylight in buildings seems to be a spanking-new strategy to offset strained illumination and to make a space increasingly well-appointed and enjoyable for any human activities. Quality of daylight is essential, therefore it is very reasonable to ensure that daylighting has an important role in building construction for any purpose, especially office building. Daylight can provide a dynamic contribution to the human wits in buildings and, as proved in recent studies on offices, schools, and retail sales environments, can impact human performance.

Successful daylighting diamond can reduce electricity consumption and can result in energy savings in offices during the daytime when daylight is available. Traditional vertical windows can provide sufficient daylight in front of window spaces but, also provide unwanted glares that are not comfortable for human's normal eyes. Atria, skylights, and roof monitors may light areas remote from vertical windows but they are used in lighting deep cadre areas. A number of systems exist to redirect daylight into areas of buildings that cannot be illuminated by glazing. One of the common group known as 'beam daylighting' redirects sunlight by subtracting reflective or refracting elements to the windows The other second major group of redirecting devices known as Tubular daylight guidance systems is known as Light Pipes or Sun Tubes. International Energy Agency indicates that in order to obtain energy savings from daylighting, it is necessary to use lighting zones and photoelectric controls. Besides these necessities, there are some approaches, known as design tools, which characterize the daylighting design process. These tools might help the designer achieve realistic results in predicting the daylight performance of a reference room or a light pipe. The results are affected by the physical properties of the reference room, characteristics and complexity of the light pipe, location of the building, and position of furniture.

NECESSITY

Nowadays office is our second home because we spend more than of the time in the office building only, different kinds of shifts and hectic work schedules are part of our life now so, we as project managers and architects need to create or design such place that the employees or users are much more comfortable into that space. While designing indoor spaces it is very important to assume the lighting level or daylighting. As an architect or engineer, we should not forget the natural things which are readily available in the environment. When we design a building at that time we didn't pay much attention to naturally available Sunlight instead we design buildings where you need artificial lighting 24x7 in the indoor space for working.

- Providing proper light guide system means introducing or providing the daylight in to the tertiary areas of the interior spaces.
- Providing natural light increase working environment and also comfort zone of the employee.
- Increases the productivity and health of the workers who spend almost more than half of the time in the offices.
- Reduces the artificial numbers of light which ultimately saves the electrical cost.
- The main advantage of providing daylight into the office spaces is to create calm and productive environments that connect the people to the environments.

SCOPE OF THE STUDY

Daylighting system is very popular nowadays and a recent area of research. Tubular daylighting devices mean TDD is a very innovative system that collects daylight and distributes daylight into the interior spaces specially designed for the deep and core area of the office.

Tubular daylighting device i.e. TDD is a very easy and innovative device for building where daylighting is necessary. This device not only uses the perimeter of the building for daylighting but also uses the vertical and horizontal ducts in the deep plan or multi-storied buildings. Moreover, this unique design will reduce energy consumption by replacing artificial lights with natural daylight and also provide a healthy working environment.

PROBLEM STATEMENT

Due to the need for energy conservation and raising demand in utilization of daylight has become a crucial issue in the design and construction of buildings. Providing natural light in the rear or deep core area of the open plan buildings has always been a challenge for architects and building designers. As daylight can penetrate or travel only a limited distance from the window, the question is how natural light can be transferred into the deeper area in the office to improve visual comfort in workplace conditions for office workers and energy efficiency. Innovative daylighting systems may be the answer to this question. TDD can bring natural light to the deeper area of the building. Previous research has shown that this system has enormous potential to transfer daylight into a deeper area of the building. There are problems in open open-plan office with daylighting. As an open-plan office has a deep area and windows only provide limited daylight, artificial lighting is employed to provide light in the interior of the office. Using larger and taller windows will increase the non-uniformity of lighting and glare problems. Furthermore, due to inconstant cloud formation and glare problems in tropical climates, workers usually close their windows and use artificial lighting

TUBULAR DAYLIGHTING DEVICE

History

The tubular daylighting system or sola Pipe or light tube is one of the oldest and most popularly known types of devices that are used for daylighting. The TDD concept was originated by the ancient Egyptians. The first tubular daylighting device system was patented in the 1850s by Paul Emile Chappu in London, using different forms of angle mirrored devices or designs, which were in production up to 1943. After that, this Tubular daylighting devices concept was redesigned and rediscovered and again patented in the 1980s. This revised and redesigned concept of the tubular daylighting system has good potential to provide daylight without unwanted glares and heat and almost covers all the areas where traditional skylights and windows are not an option

In history, natural light or daylight is the main source of lighting in the building. Recently daylight has been supplanted with electrical energy. Fortunately, during the last quarter of the twentieth century and an early long period of this century, architects and engineers have perceived the significance and benefits of brining regular daylight into the buildings. Le Corbusier so unmistakably recognized the significance of the light in engineering and he made a statement *"Architecture is the masterly, correct and magnificent play of volumes brought together in light ..." (Le Corbusier) emphasizing that* the history of architecture is the history of the struggle for light." In the history of the struggle for light, we all know that daylight is a good system to reduce the use of electrical energy and to create a space more comfortable and glare-free, but this system is also has its own design differences like any other system. The differences come from the different types of sunlight available at different times of the day. Sunlight hours can provide a dynamic contribution to the human enjoy homes and as proved in recent studies on offices, schools, and retail sales environments, can impact human performance. Successful daylighting design can reduce electricity consumption and can result in energy savings in offices during the daytime when daylight is available.

The different types of traditional windows in the building can provide maximum daylight in front of the window or near the window but since day passes and daylight starts decreasing in front of the window and

maximum amount of solar radiation must be introduced in front of the window or desk which is uneasy to work for workers who are working in such areas. so this observation is important for balancing the daylight with electrical energy consumption. Nowadays there are so many different kinds of techniques available to transfer daylight into the areas where buildings cannot be illuminated by glazing. While talking about natural daylighting systems there are two major systems available in the market is Tubular Daylighting System and second is the Beam Daylighting System.

DAYLIGHT AND DAYLIGHTING

This note is really important to understand the difference between daylight and daylighting.

- **Daylight** – "The light provided"
- **Daylighting** – "Used to provide the daylighting"

Daylight means a light that can be passed from a window and which is different than artificial light. It is said that daylighting is always better than artificial lights or electrical lights then there are valid reasons for it to prove that. Let's see, for example, daylighting is inherent, it provides better illumination than artificial lights or fluorescent lights, connects with nature, and provides a healthy and glare-free environment.

Figure 1: Daylight (Source: Inspiration Everywhere Posted on March 14, 2016)

Figure 2: Daylighting (Source: strategiesonline.net)

CONCEPT OF TDD

- A device that can bring daylight into spaces such as deep-plan offices where windows are not an option
- A daylighting system that avoids the problems of glare and excessive solar heat gain

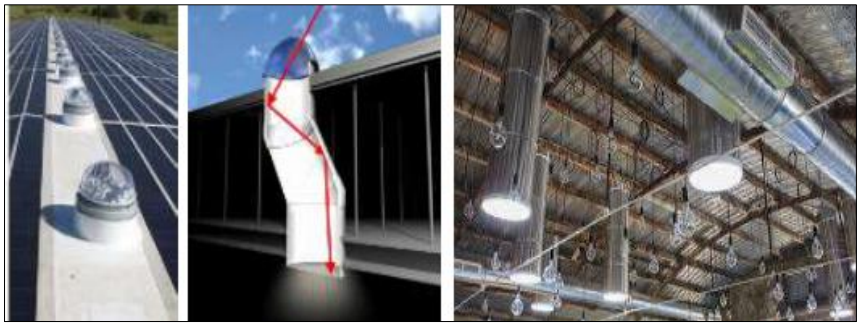


Figure 3: Tubular Daylighting

CLASSIFICATION OF LIGHT PIPES

TDD i.e. Tubular Day lighting system is basically a light tube through which natural outdoor light can be transmitted into the dark spaces. This device is totally custom oriented means they can be available in different sizes and shapes. The reflective surface is the fixed internal side of the tube through which light strikes on the surface of the pipe and light is transmitted to the internal area of the room. The light that is transmitted either light is diffused light or transmitted light. Classification of the light pipe totally depends on the site where you are going to install this device and surrounding areas, these parameters are really important while installing this system because, according to this you will get the maximum or minimum sunlight.

There are two main types –

1. Vertical light Pipes
2. Horizontal Light Pipes

1. Vertical Light Pipes –

The vertical light pipe is installed on the top of the room i.e. on the roof surface. Vertical light pipes can transfer light into the interior area of the room where traditional long windows and skylights are not possible to transfer the natural daylight in the deep and core areas of the room.

- Here in this case a small clear acrylic dome is installed on the top of the roof, which allows the sunlight inside the tube and then it is transmitted to the diffuser.
- The light pipe is treated with highly reflective material from the internal side of the pipe.
- A transparent diffuser is placed on the interior ceiling.

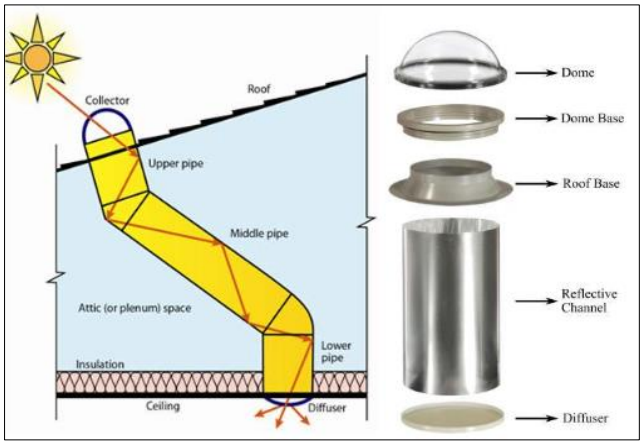


Figure 4: Vertical light pipe system

2. Horizontal Light Pipes –

- In this horizontal light pipe system which is located below the ceiling inside the room. Here light ducts are created to transfer the light from outside to inside.
- To the outside area of the building, the light collector is installed to collect the light from outside to inside and instead of a dome here, we can use the angled laser cut panels to transfer the light.
- The diffuser is placed inside the room to diffuse light light
- By reducing the no. of artificial light and power of electric usage, this TDD system contributes to CO2 discharge reduction.

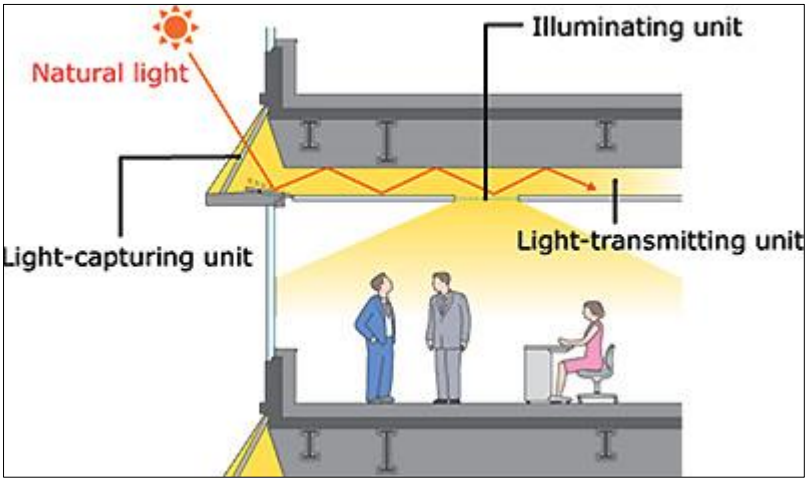


Figure 5: Horizontal Light Pipe System

COLLECTION OF LIGHT (ROOF DOME)

- In the early stages, the roof domes were made of bohemian crystal and nowadays they don't age.
- Nowadays instead of Bohemian crystal, plastic domes are used for the collection of light.
- Crystal has a great capacity for collecting daylight when there is cloud cover.
- Crystal domes don't distort the natural colors of daylight.
- The surface of the crystal is very hard and smooth and smog and dust don't stick to it as on plastic.
- Crystal domes don't yellow after several years on a roof and continue to emit light for decades

Figure 6: Roof Dome – Collector (Source: Sunpipe®)

DIFFUSER

- Diffusers are available now in different sizes and shapes according to the site and climate.
- It is possible to provide a diffuser to light the pipe for softer light or leave the pipe it empty.
- The convex shape of the diffuser is much better than the other one because it provides an equal distribution of the light.

- Nowadays different types of diffusers are available with crystal effects surface finish with flat or recessed ends.

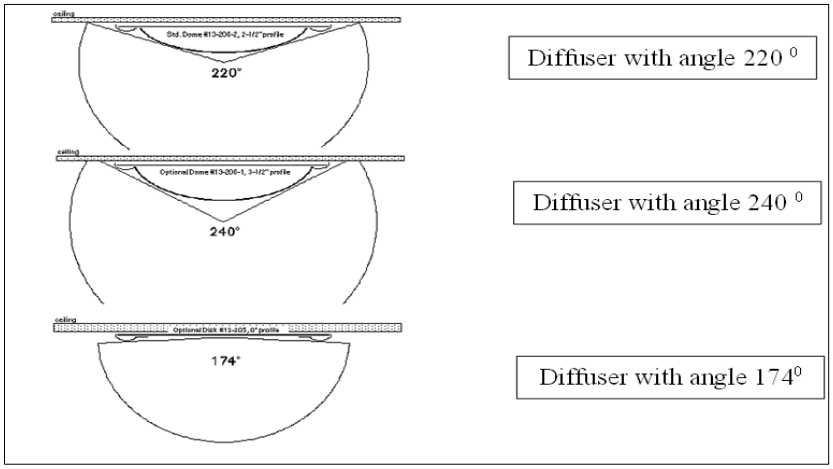


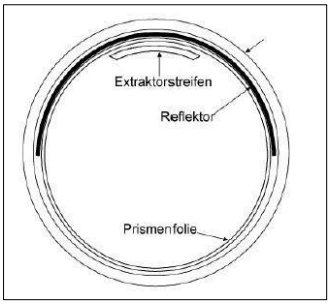
Figure 7: Diffuser and angle of reflection

ADVANTAGES OF TDD

- Solar tube skylights can provide as much natural light as traditional skylights, without being a cause of heat loss in the winter, or overheating and excess light in hot weather conditions.
- They provide diffuse and indirect natural light, and they look like a common lighting fixture.
- Solar tube skylights are small devices, relatively easy to insulate and air seal, contrary to traditional skylights.
- The light diffuser may have UV coatings to filter out UV rays, important to avoid furniture fading and other similar effects of UV radiation.
- Their redirected sunlight can help people suffering from seasonal affective disorder associated with insufficient natural sunlight.

WORKING DETAILS - LIGHT PIPE

- The hollow light guide tubes are made up of a highly reflective surface, in which the light passes through the light guide system to the interior of the room i.e. reflections.
- The first generation of the system is known as the slit light guide. The first product of this system is made up of a metallic pipe with a longitudinal slit pipe.
- The series of disadvantages of this (generation) is the relatively low reflection and rapid emission of the light.
- The second generation is popularly known as the light guide system i.e. Tubular daylighting system. Which totally corrected the mistake of the first-generation system. The second-generation system is totally based on the internal reflection of the light and less absorption or you can say it is “without” any absorption in the reflection process.
- The internal side of the tube is made up of a highly reflective material (reflectance of about 0.95). The reflectance is good to achieve the high performance of maintenance.
- The smooth surface is not so good for light reflectance because of the smooth surface it is really very hard to control the light. Therefore, the bends are created internally around the surface of the tube so that, light can be transferred and redirected



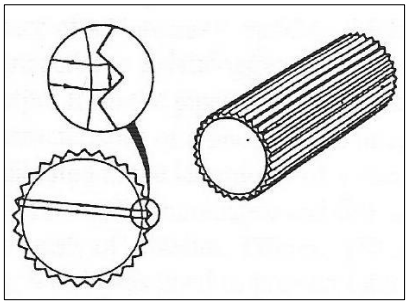


Figure 8: The Section of light pipe **Figure 9: A microstructure of pipe**

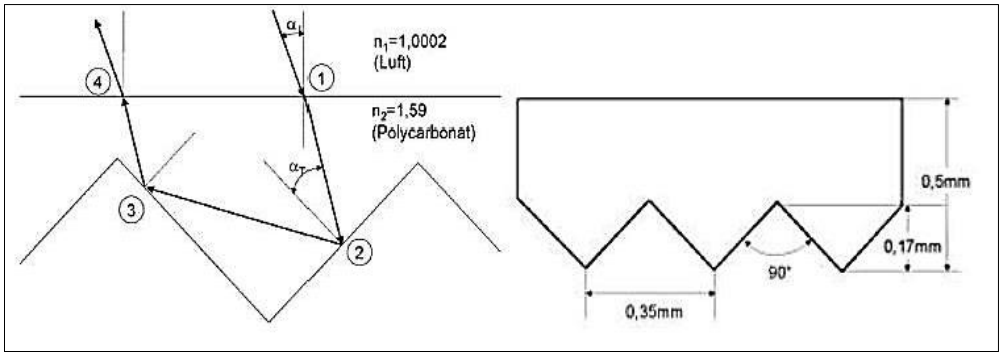


Figure 10: A light transit pipe surface structure and details

HUMAN COMFORT

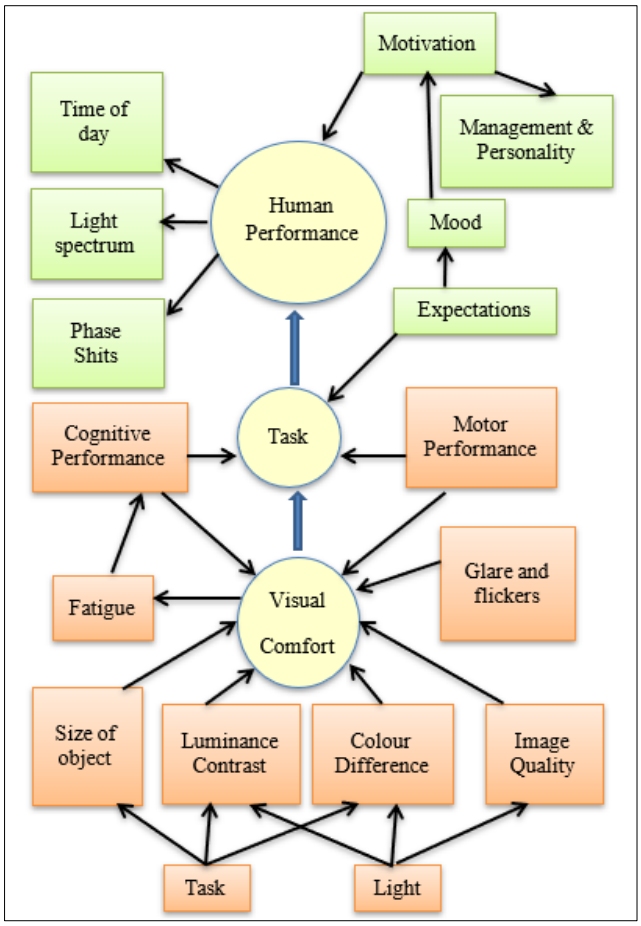


Figure 11: Psychological system and diverse fluctuations of moods and social behaviours

It is a recognized reality that light has psychological and physiological effects on human beings, the physiological impact is that humans see the surroundings and adjust their sleep cycle with the help of light. Psychologically, it actuates apprehending. Out of the several research carried out, it's been discovered that there are two elements in the theory of lighting, that cause the workplace people or employees delight, fulfillment and growth the productivity, the first one is individual control over openings, while another one is to prefer the shallow building rather than the deep-plan structure for the reason that presence of natural light and good airflow is closer

PUNE OFFICE - INTEGRID DESIGN CONSULTANCY PRIVATE LIMITED

Introduction

Building account for approximately 40% of the world's yearly electricity use even as most of the power is consumed for lighting, heating, cooling and air conditioning elements Lighting and its related cooling value constitute 30-50 of non – residential building's power use. The increasing usage of daytime system can provide better saving in electricity consumption up to 20-30% of general electricity use.

Introducing daylight hours or daylight into deep interior area in difficult with aspect lighting fixtures of easy window specifically for limited facades while top side lighting. Normally deep plan offices or areas totally depends on the electricity for lighting which is totally opposite of the sustainability concept

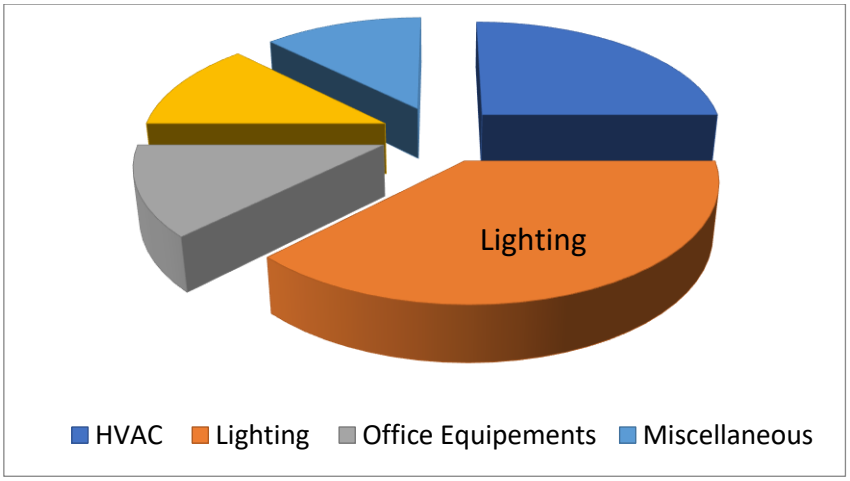


Chart: 1 Office Energy Consumption

Pune Climate

Pune is found 560 m (1840Ft) above water level on the western margins of the Deccan plateau. It's situated on the too leeward of the Sahyadri mountains ranges, which forms a barrier from the Arabian sea level. Its hilly town, with its t.a.ll.e.st hill, Ve.tal hil, growing to 800m (2600ft) over the sea level, Just outside of the town the Sinhagd fort is found at an altitude of 1300 m it lies between 18,32 north latitude and 73,51 east longitude experiences three distrunct season: summer, monsoon and winter. Typical summer months are from March to May with maximum temperatures starting from 30-38 degree cel. (95 to 107.6 degree F) Contrary to most of the De.cc.an pla.te.au where may is that the warmest month, in Pune is April. The town is usually receives locally developed heavy thunder shower with sharp down pour in May. Thought the temperatures plunge during this month, the summertime warmth amid excessive humidity are frequently every so often quite the opposite nevertheless, the nights in Pune are considerably cooler as compared to most other parts of this region due to its high altitude.

Case Study

Principle architect and urban designer, founder and father of Intergrid Design Consultants based in Pune. Designed projects starting from private residences to hospitals, institutional architecture, low-density layouts besides developing the master plans for integrated townships, notably one among the foremost awarded project – Amanora Park Town at Hadpasar, Pune.

INFORMATION	
Company name	Integrid Design Consultancy Private Limited
Location	Pune
Address	Plot no 21, Senapti Bapat road, Mangalwadi Co-operative Society, Gokhale Nagar Pune, Maharashtra 411016
Company Status	Active
Registration Number	18662
Company category	Company limited by shares
Company sub category	Non-government company
Class of company	Private
Date of incorporation	17 Dec 2003
Age of company	16 years, 3 months, 8 days
Activity	Architectural, engineering and other technical activities.

Table: 1 Integrid Design Consultancy Private Limited

Plans and Photographs

Figure 12: Goggle Image -Integrid Design Consultancy Private Limited

Figure 13: Location plan - Integrid Design Consultancy Private Limited

Figure 14: Electrical layout for office floor

Figure 15: Office Interior Images

Question for the employee in the office

a. In the designing process, the orientation of the site is important or not?

Yes, It's Important, when you're designing a building the orientation of the building and selection of the location one among the foremost important factor, particularly within the day-lighting system or building

b. Climatology of the place is considered or not?

Yes, it's considered, Climatology is vital to work out the longer term climate consistent with their regions

c. What type of techniques?

When designing a building special attention is given for the ventilation daylight, using windows, skylights, providing different openings and different reflective surfaces in order that direct and indirect sunlight we will get into the interior side of the space

d. How the daylight will manage in the building?

By using different openings, skylights, windows and reflective surfaces or another day lighting techniques is out there now a days but which is economical

e. To block the excess heat gain and heat glare what techniques are used?

For this building no such technique is provided

f. How do you feel in the office?

Our office start at 9.00 am in the morning, once we enter into the office almost 99 % of the employee feel really fresh and energetic but as soon as time passes like within the afternoon almost 50% employee admit

that they feel tired and after 3.00 PM almost energy is down simply because of the excessive amount of sunlight.

g. Do you feel physically stressed in the office?

Yes, after 3.00 PM almost 50% employee feels tired

h. Are you feel comfortable in front of the computer?

Yes, I feel comfortable ahead of computer, but who seat almost the window for them seating ahead of the PC isn't very easy due to sunlight and reflection of glare they can't see the PC screen very clearly and since of this they modify the position of the PC against to window

i. Daylight is sufficient in the office?

Yes, daylight is sufficient in the office

j. Are you using AC or NOT?

Yes, we use Split AC in the office

k. Do you have any health issue because of the minimum or maximum amount of the daylight in the office?

No not really, but some time unwanted glares effect the eyes of the employee.

Calculations – Existing Lighting Loads

Office floor contain waiting and reception area, studio -1 and 2, conference hall, office cabin, printer room, washroom and passage area

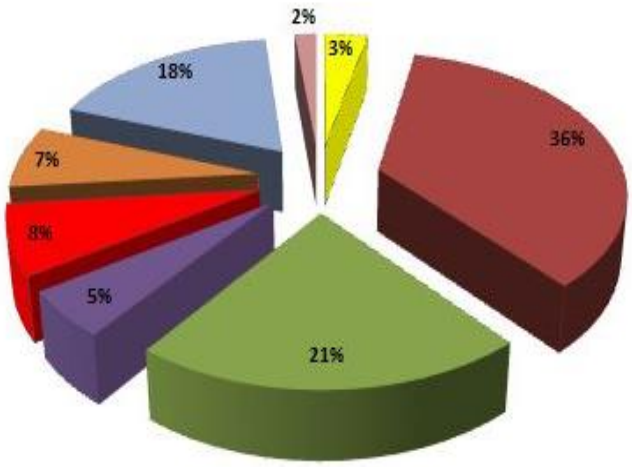


Figure 16: Existing interior light load calculation as per areas

Area	Monthly KW
Reception & Waiting Area	57.6
Conf. Hall	36
Studio -1	384
Studio -2	230.4
Office Cabin	76.8
WC Lights	18

Printer Room	**86.4**
Passage Lights	**192**

Here the office floor consume 1269 Kw.Hr per month power consumption which is shown in the above chart in this analysis it has been observed that the Studio-1 consumes 432 kw which is higher than other areas. conference hall and office cabin consume - 72 Kw, Stuido-2 consume - 288 kw, reception and waiting area consume-54Kw,reception & waiting consumes 167.4 kw, passage light consume- 180 Kw, Printer room consume- 144 Kw, washrooms consume- 27 Kw units. From above graph it is clear that more power consumption is in Studio -1 area

Calculation Chart

The following chart shows how many LED lights, or LED lumens, you need to light a room, for 3 different wattages (16 Watt, 28 Watt, 36 Watt)

16 Watt Tube Light –

Sr. No.	Name of room	Lux	Area	Lumen	16 watt BL(lumen/per bulb)	No of lights
1	Studio - 1	500	44.405	22202.5	1600	14
2	Studio - 2	500	33.84	16920	1600	11
3	Waiting and reception area	200	21.655	4331	1600	3
4	Conf. hall	500	18.5	9250	1600	6
7	Office Cabin	500	16	8000	1600	5
8	Printer Room	200	10.7675	2153.5	1600	1
9	Washrooms	200	6	1200	1600	1
10	Passage Area	300	49.28	14784	1600	9
11	Pantry	300	28.05	8415	1600	5

Table 1 16 Watt tube light load calculation

28 Watt Tube Light –

Sr.No	Name of room	Lux	Area	Lumen	28 watt BL (lumen/per bulb)	No of lights
1	Studio - 1	500	44.405	22202.5	2800	8
2	Studio - 2	500	33.84	16920	2800	6
3	Waiting & Reception area	200	21.655	4331	2800	2
4	Conference hall	500	18.5	9250	2800	3
7	Office Cabin	500	16	8000	2800	3
8	Printer Room	500	10.7675	5383.75	2800	2
9	Washrooms	200	6	1200	2800	1
10	Passage Area	300	49.28	14784	2800	5
11	Pantry	300	28.05	8415	2800	3

Table 2 28 Watt tube light load calculation

36 Watt Tube Light –

Sr.No	Name of room	Lux	Area	Lumen	36 watt BL(lumen/per bulb)	No of lights
1	Studio – 1	500	44.405	22202.5	3600	6
2	Studio – 2	500	33.84	16920	3600	5
3	Waiting & Reception area	200	21.655	4331	3600	1
4	Conference hall	500	18.5	9250	3600	3
7	Office Cabin	500	16	8000	3600	2
8	Printer Room	500	10.7675	5383.75	3600	1
9	Washrooms	200	6	1200	3600	1
10	Passage Area	300	49.28	14784	3600	4
11	Pantry	300	28.05	8415	3600	2

Table 3 36 Watt tube light load calculation

An example is given below to understand how to calculate lights and lumen for particular area according wattage

STUDIO -1

16 watt LED Tube

Desk task (office work) required 500 lux

Size of the Studio-1 (10.70 X 4.15 = 44.405)

Lumen = Lux X Area (Sq.m)

Lumen = 500 X 44.405 = 22,202

Once you know how many lumens you need, you can start figuring out how many light bulbs will suffice to illuminate your surface. To do it, use the formula below:

(BL= lumen / bulbs which is given in product details)

Bulbs = Lumen / BL

16 watt Tube light

Bulbs = 22,202 / 1600

Bulbs = 13.87 = 14 Tube light is required for the studio-1

Therefore, 14 tubes of 16 wattages are required for studio – 1

Tubular Pipe and Lumen Output

Size	Lumen output	Electrical wattage equivalent
300 mm-12 inches	4,000 Lumens	90 W
400 mm-16 inches	8,000 Lumens	180 W
530 mm-21 inches	12,000 Lumens	300 W
750 mm-30 inches	22,000 Lumens	475 W

Table 4 TDD Chart (Size of pipe and lumen output)

12 inch Tubular Day lighting Device
Desk task (office work) required 500 lux
Size of the Studio-1 (10.70 X 4.15 = 44.405)

Lumen = Lux X Area (Sq.m)
Lumen = 500 X 44.405
Lumen = 22,202

Bulbs = Lumen / BL
16 watt Tube light
Bulbs = 22,202 / 4000
Bulbs = 5.55 = 6 TDD is required for the studio-1

Therefore, 06 TDD pipes are required for the studio – 1 which is equivalent to 90 watt lightENERGY CONSUMPTION CHART: EXISTING LIGHTING VS. TDD

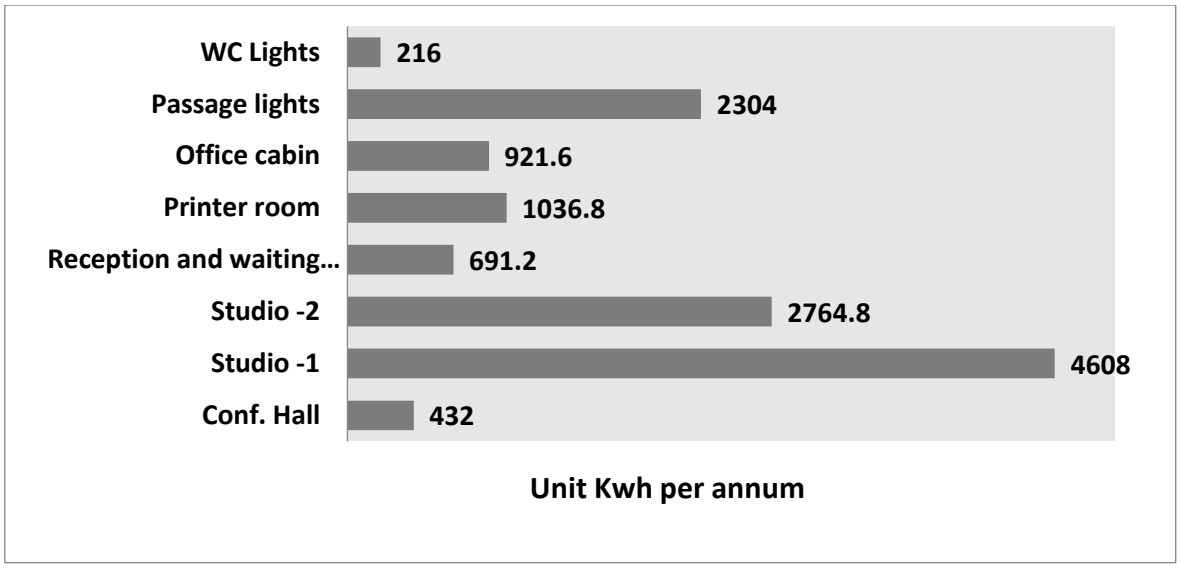


Chart : 2 Energy Consumption of Existing Lights

Energy consumption for Existing light

Area	No	W per unit	Usage	Total W daily	Total W Monthly	Unit KW	Unit KWh per annum
Conf. Hall	2	15	4	120	3600	36	432
Studio -1	10	16	8	1280	38400	384	4608
Studio -2	6	16	8	768	23040	230.4	2764.8
Reception and waiting area	3	16	4	192	5760	57.6	691.2
Printer room	2	18	8	288	8640	86.4	1036.8
Office cabin	2	16	8	256	7680	76.8	921.6

Passage lights	5	16	8	640	19200	192	2304
WC Lights	2	10	3	60	1800	18	216

Table 5 Energy Consumption of Existing Light

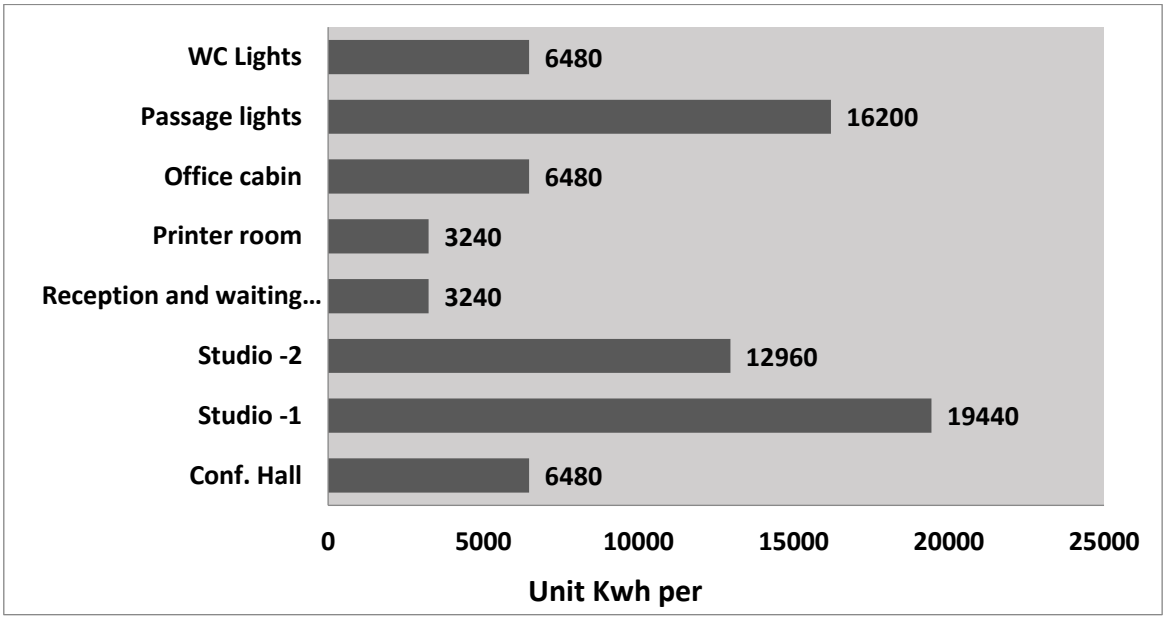


Chart : 3 Energy Consumption of Tubular daylighting device

Energy Consumption for TDD

Area	No	W per unit	Usage	Total W daily	Total W Monthly	Unit KW	Unit KWh per annum
Conf. Hall	2	90	10	1800	54000	540	6480
Studio -1	6	90	10	5400	162000	1620	19440
Studio -2	4	90	10	3600	108000	1080	12960
Reception and waiting area	1	90	10	900	27000	270	3240
Printer room	1	90	10	900	27000	270	3240
Office cabin	2	90	10	1800	54000	540	6480
Passage lights	5	90	10	4500	135000	1350	16200
WC Lights	2	90	10	1800	54000	540	6480

Table 6 Energy Consumption of TDD

TOTAL SAVINGS ON LIGHTING

Area	No	W per unit	Usage	Total W daily	Total W Monthly	Unit KW
Conf. Hall	2	15	4	120	3600	36
Studio -1	10	16	8	1280	38400	384

Studio -2	6	16	8	768	23040	230.4
Reception and waiting area	3	16	4	192	5760	57.6
Printer room	2	18	8	288	8640	86.4
Office cabin	2	16	8	256	7680	76.8
Passage lights	5	16	8	640	19200	192
WC Lights	2	10	3	60	1800	18
					Total	**1081.2**

Table 7 Total Saving on Lighting

- **Monthly Consumption – 1081.2 KW**
- **Energy charges for MSEB Commercial rate – 10RS/ unit**

Total = 1081.2 X 10 Rs.
Total = 10812 Rs.
Therefore, 10812 Rs monthly we spend on the lighting
Yearly- 129744 Rs
20% considered for Annual repair and Maintenance
Annual repair and Maintenance – 25948.8
= 129744 + 25948.8
= 155692.8

CALCULATION OF TDD COST

The initial cost of TDD = 15000
The total no of TDD required for the office is 23 no
Final Cost (Instalment and initial) = 15000 x 23
Final Cost = 345000
= 345000 / 155692.8
Payback time = 2.21 years

CONCLUSION

The result of the study indicated very high use of artificial mild and excessive use of electrical electricity inside the workplace with excessive glare and direct daylight issues. The worker in the office feels tiredness and strain during working hours because of the direct sunlight and glares and with all this direct daylight we're using artificial light for all-day
So according to the above comparison, it's far clear that we required light consistent with the dimensions of the room and activity. It is stated that if we use the tubular daylighting device for this office then we can reduce the artificial lighting and electrical intake.
Tubular skylights have the gain of nearly no heat benefit whilst getting the desired visible comfort and illumination interior. At the least for 8-10 hours a day, throughout working hours, steady, nearly maximum illumination is acquired by the use of tubular skylights. This guarantees healthful operating environments with exact strength savings.
The preliminary value and installation price sounds discouraging around Rs 15000/- in keeping with skylights or TDD, however the benefit of zero operation and maintenance cost (almost 20%) favour their usage

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