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Natural Lighting Efficiency By Means of Sun-Skylight-Tubes

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Abstract*— The notion of comfort a luminous ambience refers to the distribution of luminance and chromatic ties on the interior envelope of a space that is one of different fields of vision for a subject within an ambience. Luminance and chromatic ties are at present not often studied as far as comfort in buildings is concerned. Sun lighting and bioclimatic concept is inseparable considerations when designing a building because of the historical and practical significance of natural lighting in architecture. Sunlight is as old as architecture itself. Human life gets sufficient sunlight, in fact, we use more of 90 % of our day indoor, for this reason, specialists are now seeing how architecture can ameliorate the indoor-outdoor links. At present, by biological and technological investigation the trend is to search backwards towards the previous philosophies and advantages of more indoor / outdoor relationship. Plus homeowners who want to have healthy home environments might want to renew the most relevant facts of technology and biology.

Index Terms*— Natural lighting, Sun skylight tubes, Daylight efficiency, Collector Sunlight.

I. INTRODUCTION

In ancient times, men revered the sun directly, as a giver of light and life. Today this worship takes a new form. The sun affords warmth, comfort, health and the like, building up a general sense of security. In this way these very things become associated in our minds with the sun, which thus acts as a symbol for all these desirable conditions Light allows men to live and work and pray together. Beyond this, it gives a theme which may run through a whole space, much as a musical theme runs through a whole composition. The architect is in a way a composer using light as a theme [14]. The light by which we see the spaces we inhabit gives them their own peculiar character: it may make them intimate or over-whelming, comforting or threatening. One of the biggest difficulties facing the architect when he first comes to study the psychophysical approach to the environment is that of the re-appraisal of his knowledge of basic physics. This is, perhaps, most true when he has to consider problems of light in buildings. So much of his basic study of physics has been to encourage him to discount the evidence of his own eyes, and to rely on what measurements made by devices of all kinds can tell him. After years of this kind of training at a formative stage of life, it becomes almost a heresy to find that once again he has to go back to observing with his own eyes and believing what they tell him, rather than what the reading of a meter tells him.

If the turnabout was complete, it might not be so difficult, particularly for the architect, who must be observant by nature, but it is only a partial apostasy [15]. Light gives us freedom, while darkness imprisons us. More particularly, light gives men the freedom to be creative, to build shelters, to live and work together [14].

All forms of energy use in buildings should be analyzed, related to the different needs of individual architectural programs, to see where savings can be made; for example in homes, the use of the natural source has always been paramount during the day, so few savings can be made. The most obvious vehicle for energy saving in buildings is in exploiting the most abundant source of light accessible to us daylight. Environmentally conscious assessments of architectural design are recognizing that daylight (and natural fresh air) is a significant commodity and should be exploited to the full. Generally, people when asked, always prefer to work in a daylight environment. There is a growing acknowledgement that daylight produces positive effects, both physiological and psychological. Forms of control are necessary to limit the potentially excessive levels of daylight, if it is not to become a nuisance, particularly on bright sunny days. A passive building is one in which the greatest use is made of natural resources such as natural light, solar power and ventilation derived from making use of the natural environment. Nature cannot provide all that is necessary, and even during the day there may well be a need for some additional energy use, in terms of lighting from artificial sources, or ventilation from some form of fan assistance, whilst in terms of solar power, this can be used to advantage [5]. To bring more daylight into the home, consider bottom-up shades that open windows to the upper reaches of the sky, skylight, or peninsulas of windows, such as a bay window. Which we are going to winter, it becomes also more significant to build opportunities to go outdoors during the daylight. Shortening daylight causes blue funk in 1 to 10 % of the population, according to mead. This condition is called the winter blues or seasonal depression. Also in winter is the tendency to gain weight or experience sleep disorders. Light can also be used to make getting up in the morning less stress. It is best if you place your bedroom with Windows on the East side of the House, the Sun will wake you up if you want to get up at sunrise. The most important task in lighting design is to achieve the necessary level of illumination to enable work to be done easily and without visual strain. In practice, however, it is not easy to achieve the necessary levels of illumination without introducing some form of glare. Glare arises when some parts of the field of view are bright in relation to the general level [15]. Architects and designers have obligation to find the optimal and the intelligent solution, which correspond the importance of naturally light for these functional spaces. Some of these solutions are through determinate some certain direction by arteries optics or some of the optical canals, which conduct the light from brightness, side of building to the darkest building spaces.

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The bigger the hole in the wall and the more stretched it becomes, the more light it can admit into the building, and the better the view for the occupants. For those rooms which are likely to be inhabited most of the time, the study of day lighting, sun penetration, glare and view should preferably be made when determining the size and shape and position of the windows [14]. The use of advanced day lighting technologies, such as sunlight tubs, optical arteries, illuminations canals, and of course improved windows, may increase the amount of daylight available inside buildings. The most effective day lighting strategies might still be the simplest: optimized building orientation and form, optimized windows size and placement, a light switch, maybe a light shelf. In the following subjects, we will describe some these concepts.

II. NATURAL LIGHTING EFFECIENCY AND BUILDING ORIENTATION

In lighting problems, as will be seen shortly, there is the question, purely quantitative but based on subjective judgments, about how much light should be `spread over' the working area. Next, there is the question as to how this light can be provided without introducing discomfort from glare. Finally, there is the problem of achieving these functional aims while still providing an agreeable and attractive visual environment [15]. The meaning of orientation in an architectural space have to be considered at the outset, when the architect is planning the position of the building on the site, the aim being to guarantee the maximum accessibility of practical natural light and sunlight to the inner space. The architect will have the maximum flexibility to obtain the building orientation right on a green field site, where he can plan the location layout to take benefit of the sun path and the accessibility of the daylight. There may of course be severe restrictions where the building is locate into a rigid street model, or where there are severe external obstructions; but even in these circumstances the best use of the day lighting available should be considered. Each architectural program whether an office, school or religion buildings, will have its own specific needs of orientation, and this is of special significance where the interior function is one requiring the inhabitants to sit in fixed positions, often the case in offices or classrooms. Another aspect of orientation and one where the mere presence of day lighting is reassuring, is the subconscious desire of people when inside a building to keep in touch with the outside world, whether to know the time of day or the nature of the weather. An example of this might be taken from the modern shopping centre. The most effective day lighting strategies might still be the simplest: optimized building orientation and form, optimized windows size and placement, a light switch, maybe a light shelf. In the following subjects we will describe some of the new methods. The position of a light source and the change in brightness of surfaces according to their distance from it is vital to our perception of distance. But light is more than a means for perception. As light changes in the course of the day or the season, so a structure goes through a series of phases, as though with each kind of illumination it were putting on a new garb [15].

III. SUNSKY LIGHT TUB CONCEPTS

In the case of Passive solar light tubes was developed in its present form at the end of the 1980s, and the use of advances in retro-reflective material, which was used to the tubes. Cross-sectional shape varied, but later development and commercialization focuses practically exclusively on the circular cross section. Reading in old history on Egypt, we can observe that ancient Egyptian buildings have the first idea on tubular sun- skylight tube systems, when they lined vertical shafts with gold leaf for the idea of reflecting daylight deep into their massive stone structures [2]. In the second half of the 1990s was passive solar light pipe technology grounded and outspread on commercial scale. But the focus was on improving the performance of light pipes. They use different methods including the fitting of laser cut panels to the collector, etc. [6]. This referred also to previous work with mirror light tubes, published in German in 1975, which shows that Idea existed since sometime. Passive sunlight tubes idea take some time to get wide recognition, however, evaluation of innovative daylight Building Research Establishment includes light tubes, but only for use in the transportation of concentrated sunlight. As long as there has been dark inner space, there has been the concept of brightening them using some kind of conduit with which to “tube” daylight indoors. The ancient Egyptians built sun temples that were aligned so that at sunset of the summer solstice, sunlight would enter the temple and make its way along the axis of the building to the sanctuary [2]. These sun temples helped in determining the length of a year because the sun would only penetrate the temple in that very once per year. This would indicate that they did not use candles or oil lamps to offer the necessary light. The sunlight was deflected down long underground passageways to give the light their artist’s needs. But men, in seeking shelter, need at the same time to remain in touch with the outside. At the very least there must be some break to allow passage; one must be able to enter and leave, and so there has to be some form of opening to link the inside with the outside. To be more than a mere refuge from occasional dis-comfort and danger the shelter must also have some form of light, whether this be a fire, an oil lamp or electric light [15]. The bad solution of building planning and orientation make necessary to call to innovative solutions, one of these solutions in natural lighting field is skylight tubes, where architects and designers had obligation to find the optimal and the intelligent solution, which correspond the importance of naturally light for these functional spaces. Some of these solutions are through determinate some certain direction by optical canals which conduct the light from brightness side of house to the darkest building spaces. The use of advanced day lighting technologies, such as sunlight tubs, optical arteries, illuminations canals, and of course improved windows, may increase the amount of daylight available inside buildings. In our understanding of the innovative lighting system, we can affirm that the sun-skylight tube is that system which redirects natural sunlight into interior spaces, reducing the need for electric lighting during the day. The actual sun-skylight tube is an aluminum tube lined with reflective silver sheets [13]. The greatest benefit of sun-skylight tubes is that separately from being completely energy free, there is no heat transfer with sun-skylight tubes because of direct sunlight. In addition, there is no heat gain from the electrical light equipment themselves and this element alone, drastically reduces the cooling load or else required by the building interior.

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A major further advantage, however, that is employees naturally preferred to work under direct daylight rather than under the oppressive nature of electric lighting [4]. Of all the methods of innovative day lighting, the light tub has had the most universal application. It is essentially a method of roof lighting, which by means of association with reflective tubes, directs the light to a lower level. Whilst it can be employed to direct light through several floors, this has the disadvantage of locating the pipes through the upper floors, taking up useful floor space. Light tub installations can be associated with a means of ventilation, and also with sources of artificial light which take over after dark or when the daylight outside is insufficient, using a light control system. A particularly useful application has been in domestic buildings, where a light tub can be directed to an area in the property, such as an upstairs landing, which otherwise might receive no daylight [5].Recommended font sizes are shown in Table 1.

IV. SUNSKY LIGHT TUB SYSTEM

The light tube is perhaps the most technologically exciting of innovative day lighting systems because of the long distances over which it can labor. In principle light tube collect, direct, and channel sunlight into virtually any area of a building. The system consists of three major components [2]:

- Collector/ concentrator
- Transport system
- Emitter (diffuser)

A. Collector, concentrator

Before it enters the light tube, sunlight needs to be concentrated. Heliostat is an instrument which consisting of a mirror moved by clockwork, by which a sunbeam is made apparently stationary, by being steadily directed to one spot during the whole of its diurnal period; also, a geodetic heliotrope. The sun-skylight collector represented by mirror and lens systems, while the light tube is represented by tube with reflective inner wall, which can be with or without lens system- and duct with reflective inner wall. Light distribution will be studied using transparent materials and reflector system. The mirror tub can be angled if necessary for installation, the sunlight should be angled to the south, toward the sun [7].

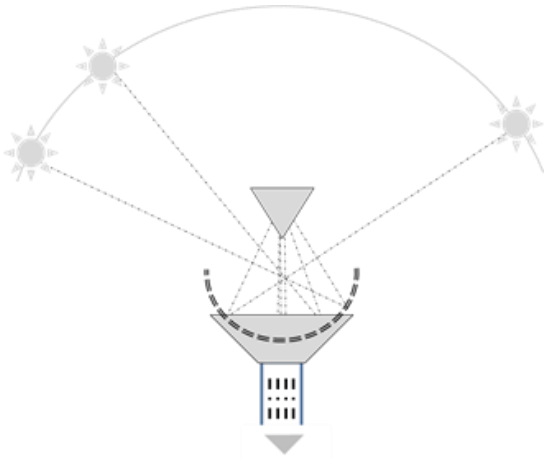

Fig. 1 Collector system role

The recommended method is for the mirror tube to penetrate the roof, plumb or vertical. Then the back of the mirror will always catch the daylight as the sun moves through the sky, making it intensive to roof placement. Below the roof, elbows can be used to move around obstacles [2]. Assembling shorter mirror tube sections into a long run will give more assembly joints. A movable mirror or reflecting system can be used to align the incoming sunlight with the axis of the light tube, minimizing reflection losses. A light tube with this feature is called a “sun tracker or follower [13].

B. Light transporter system

The most important function of the light transportation system is to transfer the exterior light source to the internal emitter. Light transporter structure can befall by optical fibre with different materials and forms, or by reflective canals [11].

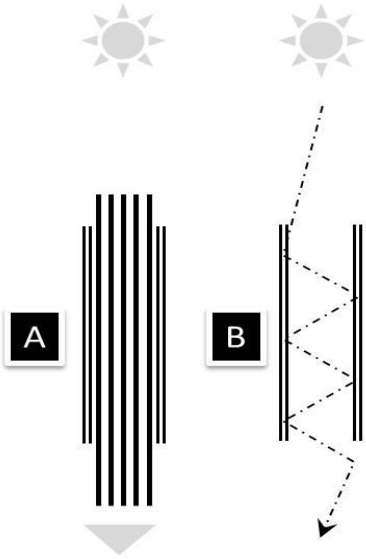

Fig 2. Light truck system A: Optical fibre B: Reflective canal

The transport system can be alienated into numerous types, the most basic form being a simple empty shaft along which a collimated beam of light can pass through [11].

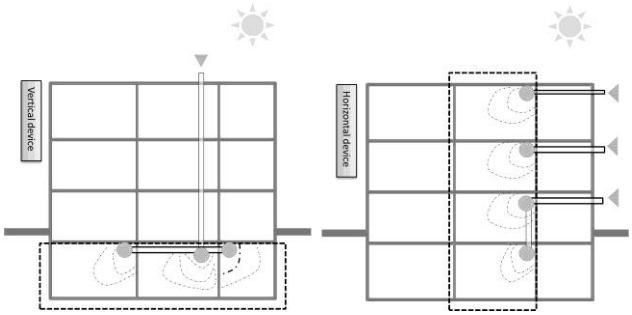

Fig 3. Light transport systems

Hollow mirrored tube, for illustration, is a system where mirrored light guides use the inner surface reflectance to reflect and diffract light over the necessary distance. It functions according to the position of incident rays competence is dependent on the ratio of length to cross-section [3]. With the increased reflections in the smaller cross-section over long distance, loss of light tends to be substantial owing to multiple reflections off-axis light beams.

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Fig 4. Sun skylight application [1].

C. *Emitter, diffuser (distributor)*

Emitters distribute light from the transportation system into the under attack spaces. Where light is piped for various distances, so that the natural source of the light becomes less obvious, it is logical to expect building users to require the same quality of light that they would get from normal luminaries [10].

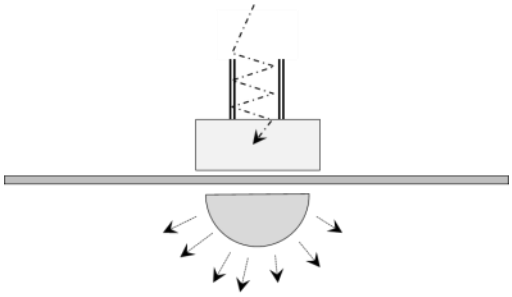

Fig 5. the light tub Emitter structure

The suggestion is a ´solar up lighter´, which uses a concave mirror to direct piped light onto the ceiling [2].All title and author details must be in single-column format and must be centred.

V. LIGHT TUB APPLICATIONS

A passive collector system is stationary, relying on solar optics to receive diffuse light. Owing to the reduced light intensity, the collector needs to receive as much light from the sky hemisphere as possible to compensate for the transmission loss. Solitary problem with the light tube system is that it will be approximately very ineffective at what time there is no sunlight. Therefore, a number of kinds of artificial backup lamp are required. An active system relies on sunlight as its primary source and tracks the movement of the sun to maximize direct sunlight [12].

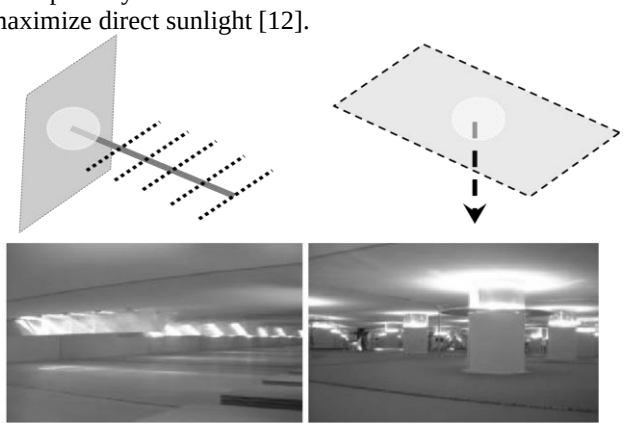

Fig 6. Horizontal and vertical sun skylight tub [10].

Sensors and an internal clock keep an eye on the process of tracking. The sensor is utilized only on clear days at the same time as the internal clock is implemented on cloudy or overcast day. The sun-skylight tube provides natural day lighting by way of a silverside mirror end the aluminium tube and the newest development utilizes the patented. The tubes can be almost any length taking the natural lighting deep into the heart of the building. A single 450 mm diameter sun-skylight tube can light up to 25 m² to regular daylight level even on cloudy days [2]. Sun- skylight tube on the other hand is playing a rising role in providing natural daylight without any of the penalties normally associated with windows or skylights [8]. Efficiency of fixed light tubes affected by the absorption which takes place when light is reflected from the walls of the tub, Except as sun increased with the axis of the pipe is the light reflected at all times when the activity through the tube.

Fig 7. Light Pipe in Potsdam Platz [1].

Although the surfaces of the tube has a high reflectance, say 90%, a large portion of the incoming light is lost with a little reflection. Light loss is proportional to the length and width ratio of the pipe. Efficiency is therefore be sacrificed if the tube is long relative to the width [9].

A. *Illumination by horizontal system*

The system work efficiency in high towers and multi-stories buildings.

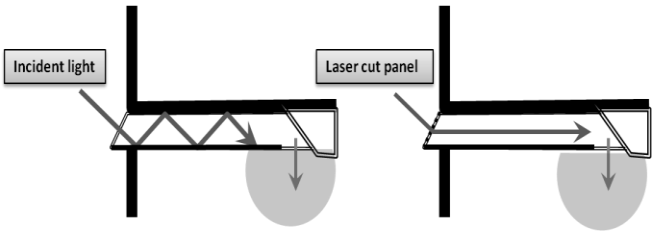

Fig 8. Horizontal Light tub with one illumination point

Light tub with one illumination tub is competent in case of one functional space building that can be cultural, social educational spaces.

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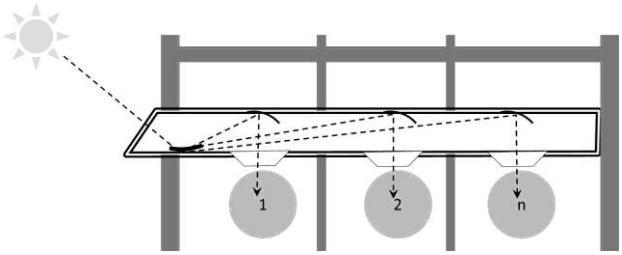

Fig 9. Light tub by horizontal system with multi- illumination points

The multi illumination points system work efficient in residential buildings.

B. Illumination by vertical system

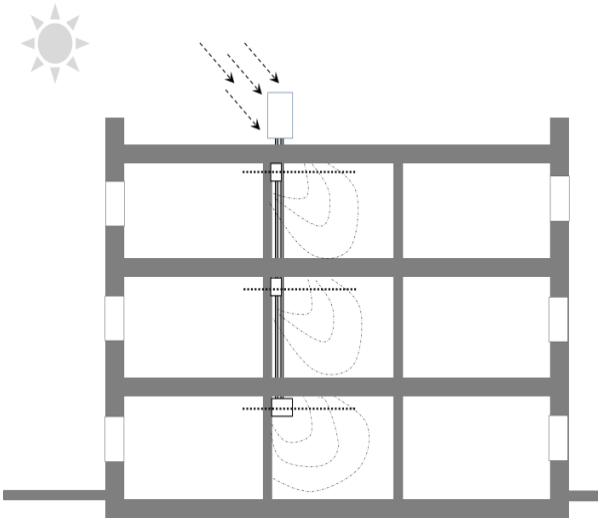

Fig 10. Light tub by vertical system

The system work efficient in low high buildings with bad orientation buildings, where is necessary to maximize the natural daylight [10].

VI. CONCLUSION

In special cases can designer oriented to activate a light tub system, to solve necessary of daylight. The light tub has to be designed to adequate the functions architectural space, orientation, ceiling form, and building materials. For an efficient work of light tub system designer must take in evidence the following parameters:

- The light tub required to be adequate in area and volume to correspond selected space functions and other building subsystems such as mechanical ducts.
- The cross section of light tub canal has to match to illumination efficiency desired by maximized illumination process, which can vary to lighting supply efficiency.
- The reflective area (reflector) has to cover the functional space for lighting requirement, and minimize waste of day light within light tub canal.

The configuration of light tub has to include sufficient reflectors to redirect daylight to functional space that can maximize lighting system efficiency

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