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SKYLIGHT USING OPTICAL FIBER

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Abstract — *Sunlight, the primary source of indoor illumination, was impacting the layout of buildings. Improvements in electric fixtures, light sources, control systems, and dimming technology have influenced standard Design practices to such a degree that allowing natural sunlight into a room considered as a liability. In the current climate of increasing energy prices and rising environmental awareness, energy conservation and resource preservation issues are atopic of governmental policy discussions for every nation on the planet. Governmental, institutional, social and economic incentives have emerged guiding the development and adoption of advanced day lighting techniques to reduce electric lighting loads in buildings used primarily during the day. Researches shows that there are many benefits of natural lighting and exposure to sunlight such as health, occupant satisfaction, worker productivity and product sales. However, apart from the mentioned benefits many complications of natural light incorporation into a lighting system are still to be solved. For example the intensity, variability and thermal load associated with sunlight can significantly damage mechanical systems and lead to serious comfort issues if additional steps are not taken to control direct sunlight. Fiber optic day lighting systems represent a new and advance method of bringing direct sunlight into a building while maintaining the controllability and ease of application usually reserved for electric lighting by collecting natural light and following it through optical fibers to luminaries within desire room. This technology has the ability to bring sunlight much deeper into buildings without inviting the glare, lighting variability and heat gain issues that complicate most day lighting strategies. As products become commercially available and increasingly economically viable, these systems have the potential to conserve probable amounts of energy and improve indoor environmental quality across a variety of common applications.*

Keywords- *Optical Fiber, Day Lighting, Solar Concentrator, Automatic Sun-Track, Sustainability.*

I. INTRODUCTION

Fiber optic day lighting systems are consists of three main components, the sunlight collector and tracking mechanism, Optical fibers and associated connections and finally luminaries to distribute light within the desire space. However electric lamps and other artificial lights are used to when adequate direct sunlight is unavailable and modulate the electric sources to supplement natural light.The collector is located on the roof with an unobstructed view of the sun while the optical fibers and cables distribute captured light within the building.

An optical fiber is a flexible, transparent fiber made from plastic or silica, having a diameter which is slightly thicker than that of a humanhair. End emitting optical fibers are used most often as a means to transmit light between the two ends of the fiber. Optical fiber is used for its principle of "Total Internal Reflection". Generally, optical fibers contain a transparent central core surrounded by a transparent cladding material. The phenomenon which governs the light through the central core is known astotal internal reflection. In other words, it helps fibers to behave like a wave guide. The main purpose of using the optical fiber is due its advantage of transmitting most probably 100% of the light.

II. MATERIALS AND METHODS

1) SOLAR COLLECTORS USING PARABOLIC REFLECTORS

A parabolic mirror was pointed at the sun and an optical fiber is located at the mirror's focal point to collect reflected light. Researchers at the Oak Ridge National Laboratory (ORNL) developed an exceptional parabolic solar collectorsystem with several improvements over the basic design Controlling the angle at which captured light entered in theoptical fibre became the focus of reflecting collector design and leading to a dual mirror approach capable of concentrating and directing incoming sunlight into a fiber nearly parallel to its centre axis.

2) TRACKING SYSTEMS AND COLLECTOR ALIGNMENT

Proper operation of a skylight using optical fiber system requires direct sunlight which has to be focused into the end of an optical fiber, but it is difficult to focus the sunlight as it continuously changes its direction. In order to focus the

Figure 1 System Alignment

sunlight continuously the sun tracking system should be provided which will follow the sun path while mirrors or lenses reflect or refract light into a group of optical fibers. Tacking systems have developed with the goals of maintaining precise alignment with the sun and maximizing operational hour's thus minimizing power required for electric lighting.

3) OPTICAL FIBERS

An optical fiber is a flexible, transparent fiber made from plastic or silica, having a diameter which is slightly thicker than that of a humanhair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber. Optical fibers typically include a transparent core surrounded by a transparent cladding material.In its most basic form an optical fiber is simply a core of dielectric material having a refractive index greater than that of the surrounding claddingmaterial, resulting in total internal reflection of light entering the fiber's end. The second layer of transparent cladding material is similar to that of the core which helps in improving transmission efficiency by capturing, as light might get scattered due to the imperfection in materials.

4) COUPLING OF OPTICAL FIBERS

Besides attenuation of light within the optical fiber, coupling losses account for the most significant reductions in transmitted light intensity. Traditionally, multiple optical fibers were connected by hand sanding and polishing the ends of each fiber and simply coupling the polished ends together as tightly as possible, often resulting in light intensity losses of about fifteen percent per coupling.When light passes through a continuous optical fiber the beam is contained in the fiber core through total internal reflection, resulting in signal attenuation only from absorption within the material itself.

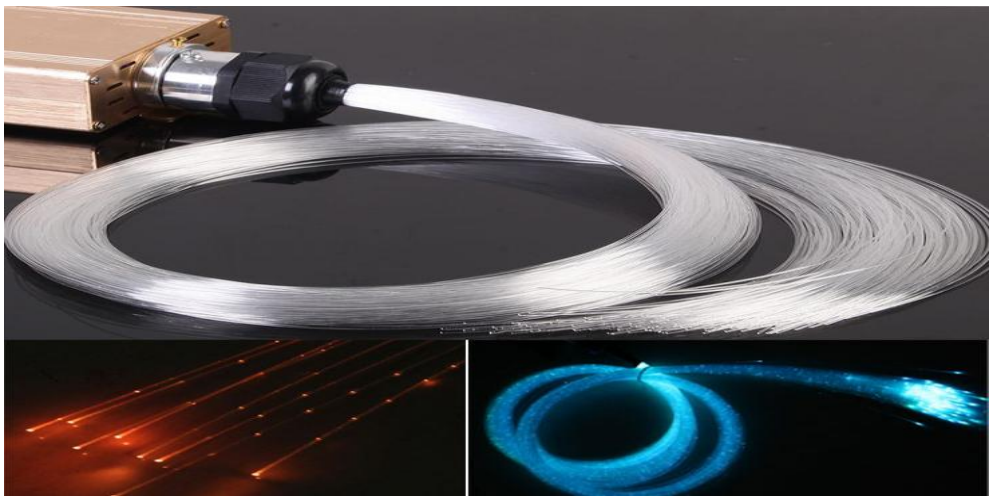

Figure 2 Optical Fibers

III. WORKING OF FIBER OPTIC DAYLIGHTING SYSTEM

- Solar lighting systems which can be placed on the roof or on the side windows focus highly concentrated sunlight into an End emitting fiber optic bundle through parabolic reflector to provide sunlight in rooms or wherever needed.
- The sunlight is collected when the tracking mechanism is used which moves toward the sun, and a series of mirrors focus the beam into the receiver. This tracking system constantly calculates the sun's position.
- The applicability and economic viability of solar lighting systems with respect to a given project depends on the building's location, thenumber of floors and the goals of the lighting design, a sentiment conveyed by the Federal Energy Management Program's report on solar lighting system.

IV. EFFECTS OF LIGHT ON OCCUPANT PRODUCTIVITY

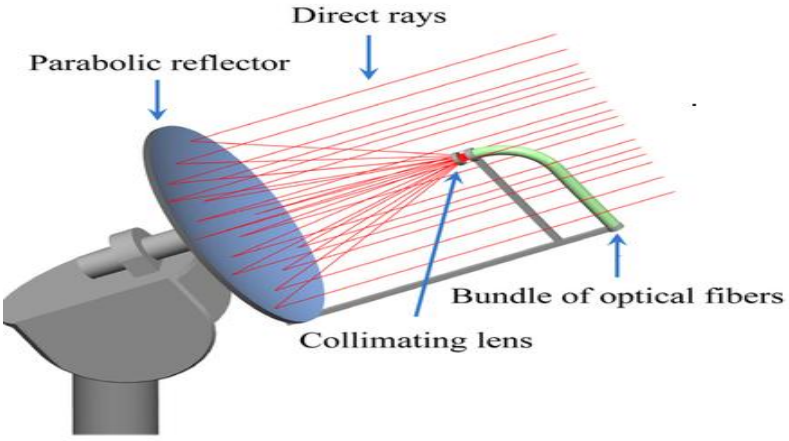

Figure 3Pathway of rays

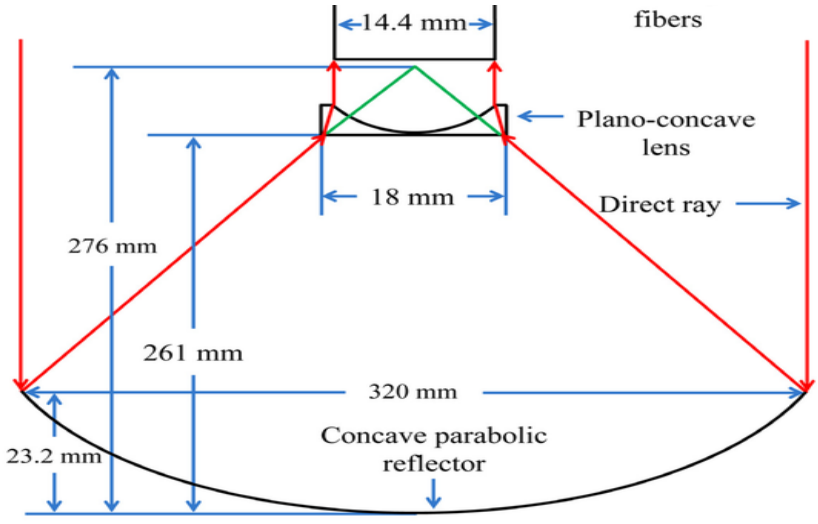

Figure 4 Distance between objects

Improvement in the health of building enhances the performance of employers and building owners. The effects of natural light on building occupants should be an important consideration for the building design. Following are the applications:-

a) EDUCATIONAL LIGHTING

- Both students and teachers can benefit from day lighting in the classrooms. Many studies have been conducted to better understand the impacts of properly incorporating daylight into classrooms without creating the negative effects associated with direct sunlight. Well-designed day lighting systems have proved to reduce utility costs, decrease student and teacher absenteeism, increase academic performance and improve student concentration and health, reduce stress factors.
- Washington and Fort Collins at the end-of-year test scores by students in classrooms with the most daylight were compared to those in the least sunlight. Students in the classrooms with high levels of daylight had 7 to 18 percent higher test scores than those in poorly-daylight rooms.

Figure 5 Laboratory lighting

b) OFFICE LIGHTING

- Occupants in offices with well-designed day lighting systems report an increase in work satisfaction and general well being. There is great difficulty quantifying benefits specifically attributable to day lighting, as it is difficult to isolate variables and determine precise impacts of indoor environmental quality.
- Some of the Office reported increased worker productivity when improved lighting and other indoor quality conditions were implemented in their respective offices.

Figure 6 Cubical Lighting

c) RETAIL LIGHTING

- Many retailers have started to explore the potential of day lighting in the retail environment. Several large retailers have started experimenting with skylights and other methods to bring natural light into their stores, improve the indoor environment, increase sales, attract customers and improve colour of products on display.

- Employees of the daylight stores reported slightly higher satisfaction with the day lighting quality conditions overall than those in the non-daylight stores.

- Most strikingly, they perceived the daylight stores to have more uniform lighting than the non-daylight stores, even though direct measurements showed the daylight stores to have much greater the variation in both horizontal and vertical illuminance levels.

Figure 7 Supermarket Lighting

Future Scope

- We can use a sun-tracking system to move the parabolic reflector on a sun path.
- We can convert the energy of the sun by providing solar panels and store them in battery for night usage.

V. CONCLUSION

- Over time, building standards and engineering practices have trended toward integrated, whole-building design approaches, which aims at maximizing functionality of the system, control, occupant's responses and quality of indoor environmental and at the same time continuously lowering allowable power densities. As in recent times the prices of electricity are increasing continuously and also the concerns regarding climate change has driven construction firms to develop more sustainable and innovative techniques which will result in improving efficiency and reduce consumption. Fiber optic daylighting systems characterises the most effective method of utilizing direct sunlight inside while maintaining the level of control desired by occupants and simultaneously mitigating the variability, glare, intensity, distribution and thermal comfort problems of traditional daylighting strategies.
- Several trial installations of solar lighting systems have been conducted in large retail stores with positive energy savings, customer perception, employee satisfaction and sales impacts. However, as products improve, design

standards emerge; commercial availability increases and energy prices continue to raise solar lighting systems will become progressively more cost effective and economically viable in a widening range of applications.

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