

“Sustainable Tubular Day-lighting System: A Review”

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Abstract - The Sustainable Tubular Daylighting System (STDS) is an innovative and energy-efficient solution developed to utilize natural sunlight for indoor illumination. In modern buildings, a significant amount of electrical energy is consumed for lighting during daytime, especially in spaces such as corridors, washrooms, staircases, offices, and storage areas where direct sunlight is limited. This project focuses on designing and understanding a daylighting system that captures sunlight from the roof and transfers it into indoor spaces through a highly reflective tubular pathway, thereby reducing the dependency on artificial lighting.

Key Words: collector dome, a high-reflective aluminum tube, a ceiling diffuser, waterproof flashing arrangement

1. INTRODUCTION

The construction industry is rapidly moving towards the adoption of sustainable, energy-efficient, and environmentally responsible technologies. Modern buildings are expected not only to provide structural safety and functional space but also to minimize energy consumption and environmental impact. One of the major contributors to building energy usage is artificial lighting, especially in indoor spaces where natural daylight is not easily available. As urbanization increases and buildings become more compact, the need for innovative daylighting solutions becomes more important.

The Sustainable Tubular Daylighting System is an advanced building technology that captures sunlight from the roof and transfers it into indoor spaces through a highly reflective tube. This system provides natural illumination to interior rooms and reduces the dependence on electrical lighting during daytime. It is considered a sustainable solution because it uses renewable solar energy, improves indoor lighting conditions, and supports the concept of green building construction.

2. Objectives of the Project

1. To study the concept and working principle of a tubular daylighting system.
2. To understand the major components of the system such as the collector dome, reflective tube, diffuser, and waterproof flashing arrangement.
3. To reduce the dependency on artificial lighting during daytime by using natural sunlight.
4. To improve indoor lighting conditions in spaces where direct sunlight is not available.
5. To promote energy-efficient and sustainable building design in residential, commercial, and institutional structures.

3. Overview of the System

The system mainly consists of the following components:

1. Collector Dome

The collector dome is installed at the roof level. It captures sunlight from different angles and directs it into the tube. It is usually made from UV-stabilized acrylic or polycarbonate material and is designed to withstand weather conditions.

2. Reflective Tube

The reflective tube is the main pathway through which sunlight travels from the roof to the indoor space. It is generally made of highly reflective aluminum sheet so that light loss is minimized during transmission.

3. Ceiling Diffuser

The diffuser is installed at the ceiling level inside the room. Its function is to spread the incoming daylight evenly across the indoor area and reduce glare.

4. Flashing and Waterproofing Assembly

This part ensures that the system is securely fitted into the roof slab and remains waterproof, leak-proof, and structurally safe.

4. Data Collection and Materials Used

Materials Used

The major materials used in the system are:

1. Collector Dome

- Material: Acrylic / Polycarbonate
- Function: Captures sunlight from the roof

2. Reflective Tube

- Material: Highly polished aluminum sheet
- Function: Transfers light with minimal loss

3. Ceiling Diffuser

- Material: Frosted plastic / glass
- Function: Distributes light evenly indoors

4. Flashing and Waterproofing Kit

- Material: Metal base + sealant
- Function: Prevents leakage and ensures structural safety

5. Sealants and Fasteners

- Used for proper fixing and leak-proof installation

6. Optional Materials

- Insulation material
- LED backup lighting system (for hybrid use)

5.Design Calculation

The design calculation of the Sustainable Tubular Daylighting System is carried out to estimate the approximate dimensions, light transmission efficiency, and suitability of the system for indoor spaces. Since this is a diploma-level civil engineering project, the calculations are kept practical and understandable

Assumed Room Dimensions

Let us consider a sample room for calculation:

- Room Length = 4 m
- Room Width = 3 m
Room Height = 3 m
Area = $4 \times 3 = 12\text{m}^2$

Required Light Output = 2400 lumens

This means the daylighting system should ideally provide around 2400 lumens of useful daylight under good sunlight conditions.

Assume a tube diameter of:

Cross-Sectional Area of Tube

$$D = 0.30\text{m} = 300\text{mm}$$

$$\text{Cross-sectional area of tube} = 0.0707 \text{ m}^2$$

- Roof slab to ceiling level distance = 2.5 m

Reflective Efficiency

Assume the inner surface reflectivity of the aluminum tube is:

$$R = 95\% \\ = 0.95$$

Slab Opening Size

For a 300 mm diameter tube, the slab opening must be slightly larger for installation and clearance. Assume:

- Tube diameter = 300 mm
- Clearance = 25 mm on each side

$$\text{Opening Size} = 300 + 50 = 350\text{mm}$$

$$\text{Required Slab Opening} = 350 \text{ mm}$$

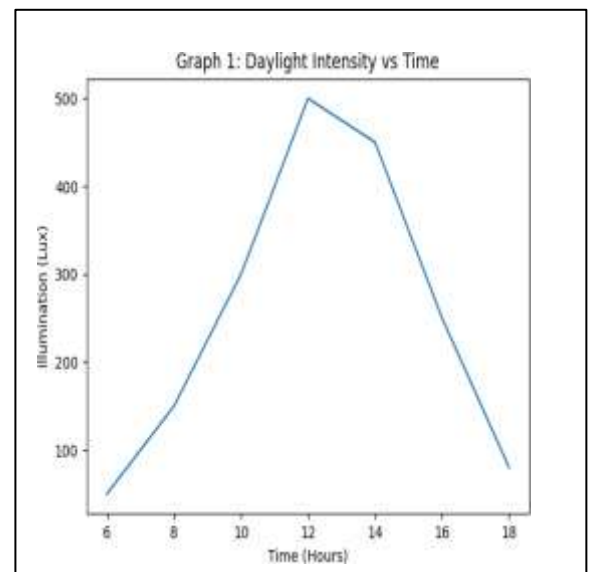
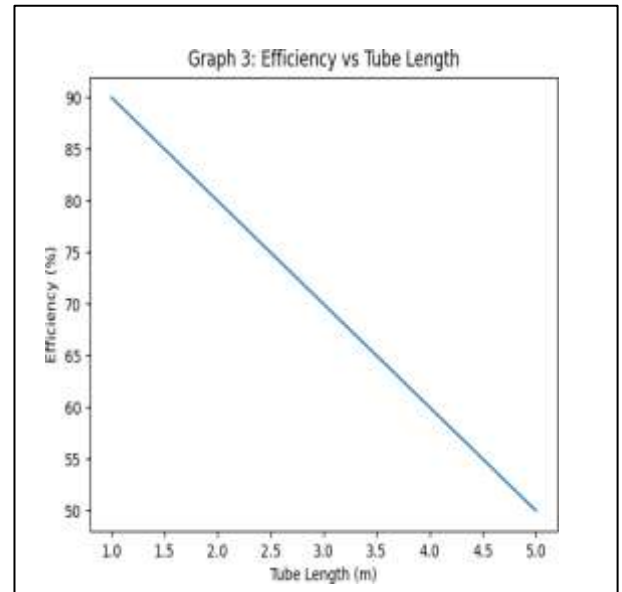
Assume that the room normally uses:

$$2 \text{ LED lights of } 18 \text{ W each} \\ = 0.288 \times 30 = 8.64\text{kWh/month}$$

$$\text{Monthly electricity saving} \approx 8.64 \text{ kWh}$$

6.RESULTS

The analysis of the Sustainable Tubular Daylighting System, along with graphical representation, live demonstration explanation, applications, and advantages. The results show how effectively the system improves indoor lighting and reduces energy consumption.



7.CONCLUSION

1. The Sustainable Tubular Daylighting System is an effective and eco-friendly solution for improving indoor lighting by using natural sunlight instead of depending completely on artificial lighting.
2. The study confirms that this system can play an important role in energy conservation and sustainable building development.
3. Hence, this project proves that tubular daylighting is a valuable step toward creating smarter, more efficient and sustainable infrastructure for the future

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