Optimization of Daylighting in Office Building.

Aashutosh Agrawal[1], Dr. Parampreet Kaur[2]
[1]*Undergraduate Student, Amity University Chhattisgarh*
[2]*Head of The Institution, Amity University Chhattisgarh*

***Abstract*— Daylighting, or the strategic use of natural light to illuminate indoor spaces, is a cornerstone of sustainable building design. It enhances energy efficiency, improves occupant well-being, and contributes to aesthetic and functional excellence. This paper explores daylighting optimization in office buildings through design strategies, case studies, and technological advancements. Two exemplary buildings—the ITC Green Centre, Gurugram, and The Edge, Amsterdam—serve as case studies to highlight best practices and lessons for architects.**

***Index Terms*— Optimization, Daylighting, Office Building, Natural light, Strategies.**

I. INTRODUCTION

As cities expand and energy consumption continues to soar, the demand for housing construction that utilizes sustainable building methodology has become of much greater importance. Daylighting, which is the strategic use of natural light to illuminate indoor spaces, is one of the most effective strategies used in modern architecture. Daylighting can be a very powerful way of reducing the energy consumed by a building, enhancing environmental sustainability, and interior quality. Daylighting is capable of significantly reducing electricity consumption through reduced reliance on artificial lighting; theoretically, it could help formulate a global approach to energy efficiency, combined with reducing the Carbon imprint in our pursuit of sustainable solutions.

The benefits of daylighting go beyond just energy savings. Natural light has been proven to advance worker productivity, decrease absenteeism, and improve physical and mental wellness. Employees that work in daylight-filled offices are much more engaged, healthy, and suffer less from tiredness and stress. The well-illuminated spaces invite a sense of connection to the outdoors, enhancing the comfort satisfaction of building occupants. However, achieving these benefits requires thoughtfulness in design.

Daylighting systems, if improperly designed, do lead to glaring problems, light distribution, and increased thermal discomfort, all of which would put building occupants' comfort at risk. Architects should pay close attention to key design aspects when trying to alleviate associated issues, which include building orientation, window-to-wall ratios, shading devices, and glazing's planet. Moreover, as buildings adapt mechanically to lighting conditions throughout the day, they might really achieve the balance requested between functionality and user comfort with the help of advanced technology such as automated blinds, daylight sensors, and electrochromic glasses.

II. METHODOLOGY

This study adopts a case study approach, examining two office buildings recognized for innovative daylighting strategies. The ITC Green Centre in Gurugram showcases passive techniques tailored to India’s climate, while The Edge in Amsterdam integrates advanced technology to create a smart and sustainable workspace. This research identifies key strategies and lessons for daylighting optimization in diverse contexts by analyzing these buildings.

III. LITERATURE STUDY

Daylighting enhances lighting quality in internal spaces, it also reduces energy consumption and electricity bills. It also creates healthier work environments, given that research has suggested that employees exposed to natural light are more efficient with rare sick days. Daylighting helps reduce the burden of energy use and thus lowers greenhouse gas emissions. While passive strategies comprise a fundamental component of architecture, requiring

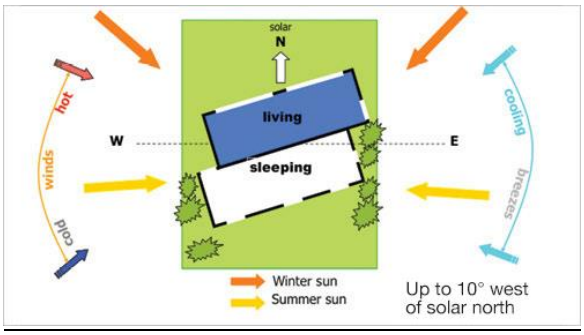

Figure 1- Cool or cold climates: living areas should be orientated as near to solar north as possible, and no more than 10° west of north
Source- https://www.yourhome.gov.au/passive-design/orientation

little or no technological intervention, architects also classify techniques as either passive or active. Passive techniques may include orientation of buildings for maximum sunlight and the use of skylights, with the latter providing very simple design solutions. On the other hand, the active techniques will actively involve the use of technological devices, such as automated blinds and a daylight-responsive lighting system that responds dynamically to changing daylight conditions over the sun's path every day. The most recent example includes electrochromic glass technology, permitting dynamic sunlight control with the highest order of thermal comfort. These effective approaches allow for green certification such as LEED and BREEAM for a building that positively contributes towards any form of environmental performance.

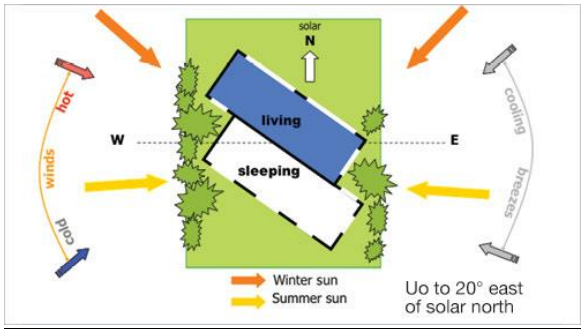

Figure 2-Warm temperate climates: as above, except living areas can be orientated up to 20° east of solar north
Source- https://www.yourhome.gov.au/passive-design/orientation

Architectural design is a vital factor benefitting from daylighting optimization. Factors such as building orientation, window size, types of shading devices, and glazing types have a major influence on natural light entering indoor space and its interaction within it. For instance, designs that favor north-south orientation provide reliable daylight, which is not overheated. Shading devices consist of overhangs and louvers and help diffusing sunlight while minimizing glare and heat by themselves, using high-performance glazing has shown to aid the penetration of sunlight while not letting in heat. Radiance and DIALux are digital tools that help architects to simulate and analyze light behavior so they can modify the design further by optimizing daylight with maximum attention to thermal and visual comfort.

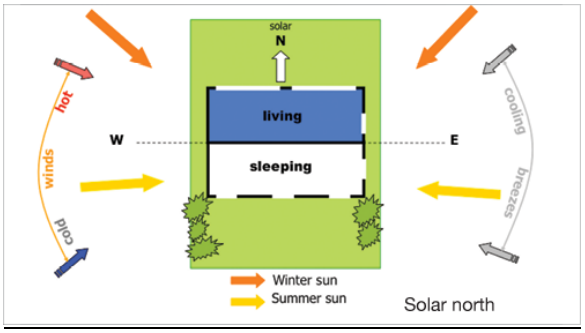

Figure 3- Temperate climates: daytime heating and cool sleeping are required
Source- https://www.yourhome.gov.au/passive-design/orientation

A. ITC GREEN CENTRE, GURUGRAM

The ITC Green Centre is India's manifestation of sustainable architecture by Hafeez Contractor. Extensively utilizing daylighting strategies commensurate with the local climate, it is a LEED Platinum building. The orientation of the building,

Figure 4- Entry façade & Atrium
Source- https://www.building.am/pagegal.php?id=310

with long facades facing north and south, means much daylight enters, whereas heating from the sun is minimal. There are double-glazed and low-e coated glass windows. This allows light into the interior space while controlling thermal gains. External shading devices such as louvers and overhangs control glare

Figure 5- The ITC Green Centre
Source- https://rkaindia.com/project-details/ITC-Green-Centre-24

and comfort. Skylights give light to common spaces such as lobbies and break-out zones while courtyards work as lightwells to bring daylight into those interior spaces that otherwise would be lit by artificial lighting. These become features that help in lowering the overall energy use associated with lighting by 30%; improve the comfort of the occupants and lower their reliance on any kind of HVAC. This is the new benchmark in energy efficiency design.

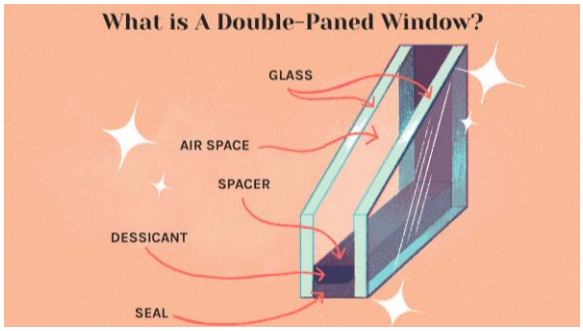

Figure 6- Double-glazed
Source- https://www.thespruce.com/double-glazed-windows-1821739

B. THE EDGE, AMSTERDAM

Figure 7- The Edge
Source- https://www.archdaily.com/785967/the-edge-plp-architecture

Zuidas, Amsterdam's burgeoning business district, rising from maturity and metropolitanism, Edge is believed to be the most sustainable office building ever built, according to the analysis carried out. PLP Architecture has incorporated daylighting into state-of-the-art technology to achieve energy neutrality. It has a 15-storey north-facing atrium flooded with glare-free, consistent daylight. This atrium serves not only as an aperture for light but also as a ventilation heart

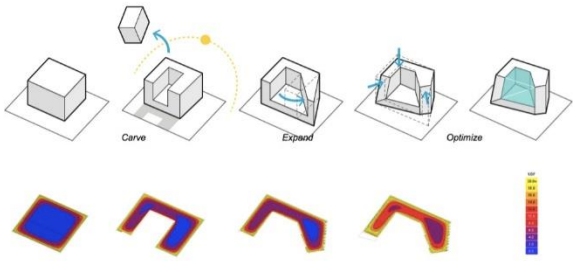

Figure 8- How the Ege's form is created.
Source -https://www.archdaily.com/785967/the-edge-plp-architecture

for the building that buffers against external weather conditions. Further daylighting effectiveness is achieved through a facade design experiment that consists of large, glazed north-facing windows, counter-balancing light and thermal performance with a smaller south-facing opening. The open floor plates allow daylight to penetrate freely, producing evenly lit working spaces. Sophisticated sensor technology and a dedicated mobile application enable employees to adapt lighting and temperature according to their needs, further enhancing comfort and productivity. Combination-based both passive and active approaches specifically give birth to the status of The Edge, i.e., an energy-neutral building to the world standard.

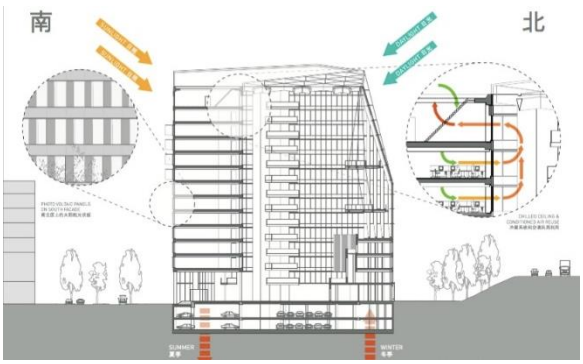

Figure 9- Showing the working of daylighting and ventilation
Source- https://www.archdaily.com/785967/the-edge-plp-architecture

IV. CONCLUSION

Daylighting optimization stands out as more than just another design choice-it is a core constituent of sustainable architecture. Through the artistic manipulation of natural light into working environments, architects harmonize energy savings, environmental sustenance, and the well-being of occupants. Case studies of the ITC Green Centre in Gurugram and The Edge in Amsterdam speak of a broad spectrum of daylighting strategies. While orientation and shading, passive mechanisms, are at play in the ITC Green Centre, The Edge takes advantage of state-of-the-art methodologies of sensors and smart systems which create a more adaptive and more responsive environment.

By combining passive and active techniques, architects can create buildings that become energy-efficient and provide the tenants with a healthier, more productive environment.

With growing urbanization and increasing demands for energy, daylighting optimization will become critically paramount for achieving sustainable office environments of the future. Future research and practice should center on how the synergy between the traditional principles of architecture and new technologies can be developed to incite even smarter, greener, and user-centric designs for buildings.

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