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Optimization of Day Lighting and Artificial Lighting in Office Building an Approach towards Sustainable Architecture

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Abstract: ***The light is an important element which helps people perceive objects. Therefore, it is important for architects to make the light and space be in harmony with each other. In this study, we analysed the works of Alvaro Size with a view to understand the conceptual value of the light expressed in his works and his principles in controlling it. According to the results of the study, the Size's architecture is not a mere theoretical one trapped inside formality, but is a sensual and experiential one based on the locality. He was willing to use void spaces to invite the light in free flowing plans, in order to invigorate and extend architectural spatiality to create deeper visual effect. In addition, the refined light in his works helped visitors experience the continuous forms and spaces by their own movements, while using the changes of the light to stimulate the interest of visitors and highlight the sequence of spaces.***

I. INTRODUCTION

In a world newly concerned about carbon emissions, global warming, and sustainable design the planned use of natural light in non-residential buildings has become an important strategy to improve energy efficiency by minimizing lighting, heating, and cooling loads. The introduction of innovative, advanced day lighting strategies and systems can considerably reduce a building's electricity consumption and also significantly improve the quality of light in an indoor environment. Daylight factor is the ratio of the light level inside a structure to the light level outside the structure. Opening serve as appliances which makes connection between interior and exterior spaces and psychologically have direct effect on human beings. Therefore, the existence of sufficient natural light in indoor spaces is more important and prefered to the existence of irritation natural light.

Beside this function, opening have three roles which are-

1) To function as an entrance for sun rays
2) To allow visual access to outdoor spaces
3) To provide ventilation

II. PURPOSE

The aim of this paper is to highlight the importance of light in all dimensions, both daylight and artificial light, in relation to architecture and to insert this debate in the field of architectural competitions.

III. BACKGROUND STUDY, DATA COLLECTION

A. Luminous Efficacy

The luminous efficacy is defined as the ratio of the emitted luminous flux to the expended electric power of a lamp. The luminous efficacy describes the efficacy of a lamp. It is expressed as the ratio of the emitted luminous flux in lumen and the power used in watts. The theoretically attainable maximum value assuming complete conversion of energy at 555 nm would be 683 lm/W. The luminous efficacies that can actually be attained vary depending on the lamp, but always remain far below this ideal value.

B. Color Rendering Index

A colour rendering index (CRI) is a quantitative measure of the ability of a light source to reveal the colours of various objects faithfully comparison with an ideal or natural light source. Light sources with a high CR1 are desirable in colour-critical applications such as neonatal care and art restoration.

The CRI of a light source does not indicate the apparent colour of the light source; that information is under the rubric of the correlated colour temperature (CT). The CRI is determined by the light source's spectrum. The pictures on the right show the continuous spectrum ofal Incandescent lamp and the discrete line spectrum of a fluorescent lamp; the former lamp has the higher CRI.

C. Importance Of Daylight

Natural light plays a very important role in our day to day life, as it provides great comfort, health, and a mood for a human being. In architecture providing a good amount of light is an integral part of our design which gives an added value. Sometimes, the main focus would be on the most effective means to reduce the overall capital expenditure and the best way to do so is by making future buildings as sustainable as possible. which helps in saving the energy used in a particular place or so. All come in different ways which are architecturally classified. Direct light entering into a certain place is all about how a certain space is designed in such a way that allows a good amount of light. An overhead light is such a trend where the windows provided on the sides don't allow a good amount of light but when it comes to providing a skylight or an opening on top would let in a good amount of light as there is direct sunlight hitting on to the roof. People these days also follow the reflecting process where the light gets reflected into certain spaces which are slightly darker compared to the other rooms. Another thing which plays a very important role is the orientation of the building about the sun. Which is one of the most influential factors is the orientation of the building concerning the sun. It helps with the visual comfort of the rooms but improves the energy efficiency of the rooms. To take the most of the sunlight and the main focus must be on the common spaces which are used and accessed by everyone. For example, being a living room service, stairs the others could be placed accordingly

D. The Location And Size Of The Windows

Usually play a very important role as the windows are huge then the ventilation and the lighting of the window will automatically tend to play a role with a good amount of light inside. These mostly affect the area like the staircase providing windows on the sides instead of providing them as a skylight would act as a reflecting surface at the same time.

Seasons which are another most important thing which plays a very important role in day lighting. As we know that in winter the sun is around 22 degrees and in summer around 68 degrees which makes the sun lower during the winters compared to the summers. For example, a window which is placed in the centre of the wall in summers the direct light coming into a certain room is less so, they tend to leave a shade. But, during the winters they create a space that keeps the surrounding warm. This depends on how we use the space and where exactly the opening is given.

Clearance around the building seems very to enjoy the beauty where there is some sort of obstruction around that wouldn't allow the light to enter directly so keeping the surrounding clear will help in allowing a good amount of natural light coming inside. In urban areas or forests, the availability of light will be difficult, therefore we need to imagine before we do something or plan something architecturally. If it's the countryside or a clearing, it will be easier to work with the building based on the environment.

E. Passive Daylighting Systems Could Transform The Architecture Of Natural Light

Natural light is a powerful architectural tool. As the importance of sustainable design grows, passive strategies like daylighting have become critical in reducing the impact of the built environment. Additionally, research in the last decade has shown daylighting to have significant health and wellness benefits for users.

Today, we have more tools than ever to harness daylight. From innovative reflective materials to advanced computer modelling, architects are using modern technology to light buildings more efficiently. When you embrace these systems, you'll create a brighter future.

F. Passive Daylighting Strategies

1) Skylights. Skylights allow daylight to enter from above, which is useful in spaces at the centre of the building where light from windows can't reach. As with windows, uniform skylight spacing results in uniform lighting. Architects can also place skylights high above the floor, allowing the light to diffuse before it reaches the ground.

2) External Shading Systems. At certain times of the day at each orientation, the light will be too bright and may produce a strong glare inside the building. To prevent this, architects design custom external shading systems to protect windows and other transparent openings. These systems usually include a combination of horizontal and vertical elements, but vary depending on the geographical location, climate, and building orientation.

3) Light shelves. A reflective horizontal shelf placed above windows reduces glare and directs light deeper into the space.
4) Solar tubes. These channel sunlight from the roof through a narrow opening. During the day, they look like ordinary ceiling lamps, but they are powered by the sun rather than electricity. These work well when placed directly above desks, where people need plenty of light.
5) Light wall colours. Light, reflective paint helps light to bounce around the room and makes the space feel brighter.

G. Guidelines For Daylighting Systems In Buildings

1) Integrate Day Lighting Design At The Concept Design Stage

Poor integration of daylighting technologies can lead to discomfort and unreliable performance.
Building floor plate depth window orientation, size and angles as well as shading and transmission
Characteristics all must be considered.

2) Building Form And Daylight Penetration

To max. daylighting potential, a shallow flood plate is preferred. Alternatively, inner coutyard, roof monitors and atrium can bring light into central cores, especially in low building.

3) Obstructions

Outside obstructions can reduce daylighting potential. The sky exposure angle is the amount of Sky that can be seen from a window. It is defined as the vertical angle of sky between the top of an obstruction and the vertical and is typically measured from a point two meters above the floor. The sky exposure angles that are required inadequate daylight

4) Building Orientation

To maximize daylighting advantages, building can be located and oriented to take advantage of the sun's movement throughout the day, as well as seasonal variations. As a general rule, building that have their long axes running east and west have a better daylighting potential.

5) Window Orientation

We receive the greatest amount of energy from the sun at noon on any given day in the year. The greatest amount of energy recived through a window is when the sun is perpendicular to the window, and 30 to 35 degrees above the horizon. A south, east, or west-facing window will receive about the same annual maximum of solar radiation. The time and date that the maximum energy is received depends on the buildings latitude and the wall orientation. The Earth rotates 15 degrees every hour, therefore, when a window is oriented 30 degrees east of south, the maximum heat gain will be about two hours before solar noon. East and west facades experience their maximum solar gain during the summer, whereas a south facing surface receives its annual maximum in the late fall or winter.

North- facing windows providing consistent indirect light with minimal heat gains, but can also create heat
Loss and comfort issues during the heating season. South-facing windows provide strong direct and indirect sun lighting. The light intensity varies during the day and controlling heat grain can be an issue in the cooling session.

Shading is easily done with horizontal shading devices. East and west facing windows can create more problems with glare and heat gain and are more difficult to shade because the sun is closer to the horizon. In our northern locations the sun is a low angle in the sky during winter, when sunlight is most needed to contribute to heating.

IV. PROBLEM STATEMENT

Opening serve as appliances which makes connection between interior and exterior spaces and psychologically have direct effect on human beings. Therefore, the existence of sufficient natural light in indoor spaces is more important and prefered to the existence of irritation natural light.

Beside this function, opening have three roles which are-

1) To function as an entrance for sun rays
2) To allow visual access to outdoor spaces
3) To provide ventilation

V. AIM

The purpose of this thesis is to investigate and evaluate the degree of common and satisfaction in the indoor office space in terms of daylighting Besides, it aims to suggest a more appropriate way of maximizing natural light to create a more suitable working environment of employing different suitable means

To achieve the objectives, the following questions are important-

1) How do the various properties of windows and window types affect the penetration of daylighting?
2) How do the various properties of shading devices affect the penetration of pleasant daylighting and prevent the glare problem?
3) How can indoor space be optimized with regards today lighting by utilizing daylighting measurements and enhance the illumination and distribution of day lighting?
4) How do the (colour, furniture, texture) effect the penetration of daylighting in interior spaces of office building?

VI. OBJECTIVES

In this dissertation. therefore the role of openings in interior spaces of office buildings as gateways of sun rays will be explored and important catena such as size, maternal, location, and installation angle of openings which leads to create apocopate openings for the office building are investigated. The examination of various kinds of daylighting measurements such as roof and top lighting (horizontal), angled lighting, indirect lighting atria, lignt courts rent rant lighting. Light shelves, louver and blind systems,, prismatic panels and amalgamation will depict preferences of each for different requirements.

1) Optimum possible use of natural light is a factor that must be considered in new construction projects.
2) Lowering environmental Impact and improving energy efficiency in buildings should be given importance by making contribution of natural lighting to the rational use of energy in buildings, and also using techniques that enable the designer to ensure that efficiency energy plans are based on interior natural lighting.
3) Controlling solar heat gains in summer, preventing loss of interior heat in winter, and allowing occupants to reduce electric lighting use by making maximum use of day light, spectrally selective glazing significantly reduces the buildings energy consumption and peak demand.

VII. METHODOLOGY OF THE STUDY

This study is initiated by getting familiar with the significance of day lighting in interior spaces, its importance in human performance it's influence on people and how the consumption of electricity can be reduced by preferring daylight which achieve less costs. By surveying the traits and characteristics of openings, daylight measurements and shading devices, importance of appropriate opening for various climates with different latitude is depicted.

VIII. SCOPE & LIMITATIONS

A. Scopes

A proper day lighting plan can reduce energy costs with little or no additional investment in systems

1) As People have a natural attraction and need for daylight
2) It can have a direct impact on well-being, productivity, and overall sense of satisfaction.
3) A proper day lighting plan can reduce HVAC (heating, ventilation, and air conditioning) costs

B. Limitations

1) As no innovative day lighting systems are likely to overcome all the challenges that's why as per the need different factor have to be implemented as per need of the building.
2) The main challenges are the high initial cost and application limitations.

IX. GENERAL CONCLUSION

1) Many strategies including the integration of daylight with artificial lighting through lighting controls can be used to contribute to energy conservation in office buildings
2) Daylight integration with artificial lighing can significantly contribute to eneray reduction in office buildings which can be enhanced by employing proper window design.
3) Optimum possible use of natural light is a factor that must be considered in new construction projects.

4) Lowering environmental impact and improving energy efficiency in buildings should be given importance by making contribution natural lighting to the rational use of energy in buildings, and also using techniques that enable the designer to ensure that efficiency energy plans are based on interior natural lighting.

5) The use of appropriate architectural standards, specification of materials and energy-efficient products and the adequacy of criteria for rational designs can enable upto 60% reduction in the energy consumption of buildings, giving architects, engineers, and designers the opportunity to explore and realize this potential.

6) The most effective method to achieve thermal comfort in offices is to reduce cooling loads in order to avail additional energy-consuming device for cooling.

7) Controlling solar heat gains in summer, preventing loss of interior heat in winters and allowing occupants to reduce electric lighting use by making max. use of daylight spectrally selective glazing significantly reduces the buildings energy consumption and peak demand.

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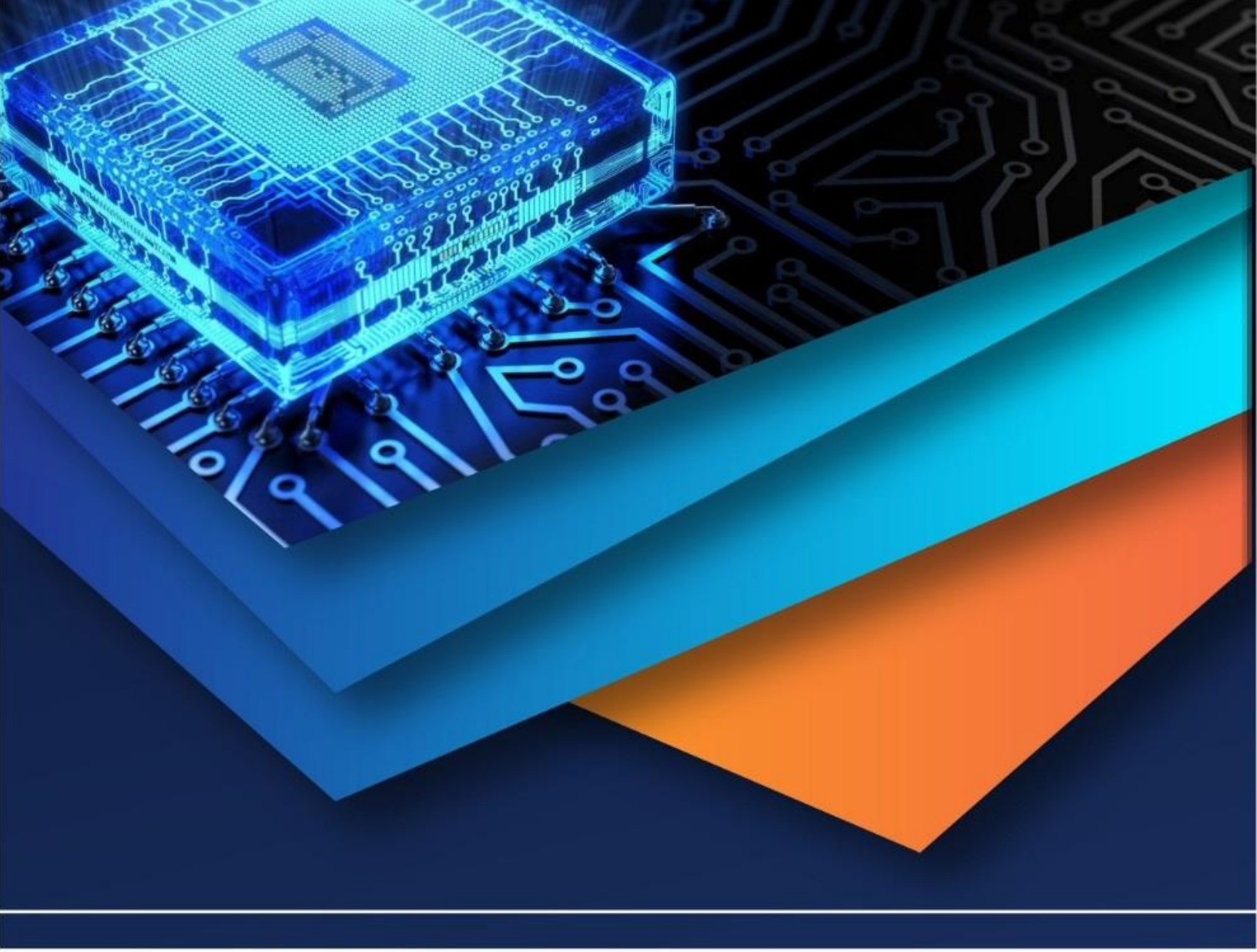

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