Day-light Analysis of an office building to enhance its energy efficiency

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Abstract. Sustainability has become increasingly significant in the construction industry in recent few years. The structure is considerably liable for 33% of energy consumption for cooling and counterfeit day lighting alone. In this way, energy consumption is a significant rule that needs extraordinary consideration while thinking about feasible structures. Under the circumstances, the need of the day is to adopt sustainable green building design approach which is a definitive answer for decrease the energy demand request of the structure. Various alternate energy sources like solar, wind and geothermal energies end up being better in making an energy efficient built environment; alongside these rules successful usage of daylight plays a crucial role in creating energy efficient buildings. Ecotect day light simulation analysis is one such case which briefs up the concept of energy efficiency. This Software has been utilized to calculate building's energy consumption by simulating its setting within the environment. It shows the sun path and shadow examination of a project or a structure on a specific day, time and spot consistently, which would support the specialists and architects/designers to go for elective designs for viable utilization of day light in development extends, this could before long become a vital piece of building and engineering plan for vitality proficient structures. This paper surveys and analyses of an office building and gives data about the day-light analyze simulation of a structure for accomplishing the best effectiveness of natural lighting and energy saving during the daytime to reach optimum daylight performance in building using the Ecotect Software.

1. Introduction

The world is recently worried about carbon discharges, a global warming, and reasonable structure, the planned use of natural light in non-residential buildings has gotten a significant procedure to energy efficiency by limiting lighting, warming, and cooling loads [1]. The presentation of inventive, progressed daylighting procedures and frameworks can impressively diminish a structure's energy utilization and furthermore altogether improve the quality of light in an indoor situation. Proof that light is alluring can be found in research just as in perceptions of human conduct and the game plan of office space. Windows that concede sunlight in structures are significant for the view and association they furnish with the outside [1]. Day Light is the is the mix of all immediate and circuitous sunlight during the daytime. It is the light to which each individual is normally adjusted; it is the light against which every other sort of light is estimated. Chroned structures consistently utilized the wellspring of regular light and after a short hole, resumption in the able utilization of sunlight is by and by being viewed as a basic component in the plan and working of structures of high building quality [2]. Sunshine is likewise significant for its quality, unearthly organization, and inconstancy. An audit of people groups’ responses to indoor situations recommends that sunlight is wanted in light of the fact that it satisfies two exceptionally essential human necessities: to have the option to see both an errand and the space well, also, to encounter some natural incitement. Working long haul in electric lighting is accepted to be injurious to wellbeing; working by sunlight is accepted
to bring about less pressure and uneasiness [1]. The enhanced plan of natural day lighting for structures can incredibly decrease the energy utilization and improves indoor comfort quality alongside physical and mental health of the occupants. Utilizing daylight as a significant wellspring of light, a decrease in power utilization can be accomplished somewhat. Actually, A force transition of 63 MW is delivered by the sun which is proportional to 6000 million lumens/m² of its surface region. Sunlight in LEED alludes to associate structure inhabitants with the outside, fortify circadian rhythms, what's more, diminish the utilization of electrical lighting by bringing sunshine into the building space [3]. Planners should consolidate measures for LEED/GRIHA/IGBC light credit into building configuration process while considering heat increase and misfortune factors, glare control, visual quality and varieties in sunlight accessibility for accomplishing the best effectiveness of natural lighting and energy saving during the daytime to reach optimum daylight performance in building [1].

Figure 1: Daylight in building

2. Day light analysis

2.1. Need for day light analysis
The advantages of bringing light into a building can be refuted by an inappropriate treatment of the sunshine being presented. Sunlight gives high illuminance and licenses super shading separation and shade delivering. These two properties imply that sunshine gives the condition to great vision[2]. In any case, sunshine can likewise deliver awkward sun powered glare and very high luminance reflections in plain view screens, the two of which meddle with great vision. Consequently, the impact of sunshine on the exhibition of undertakings relies upon how the light is conveyed. Awkward glare and warm conditions, just as veiling reflections and high difference proportions, are instances of ominous conditions that can be made by poor daylighting. These components should be considered in daylighting plan for structures [1]. Subsequently, it is imperative to actualize an intensive and effective way to deal with daylighting structure. The essential purposes behind utilizing daylight to meet the brightening necessities of a building space are the mental advantages and the vitality reserve funds benefits. Great daylighting has been appeared to improve the general demeanor, fulfillment and prosperity of building tenants Daylighting, with legitimate electric lighting controls, can bring about huge vitality reserve funds by decreasing electric lighting loads and related cooling loads [4].

2.2. Scope of day light analysis in building

2.2.1. Quantity
Give encompassing lighting prerequisites during daytime hours for most of the year.

2.2.2. Quality
Make uniform dissemination of sunshine to diminish awkwardly high splendor proportions. Control direct daylight when important and use valuable inactive sun-based techniques when fitting.
2.2.3. Usability
Take into account client alteration and supersede. Guarantee satisfactory sunshine to all tenants of the
daylight space. Give view and association with the outside.

2.2.4. Building Integration
 Completely coordinate with the engineering articulation of the structure all around. Completely
incorporate with other structure frameworks - HVAC, Electrical, Lighting, Structural, Interiors.

2.2.5. Cost Effectiveness
Actualize inside generally speaking development financial plan of the task. Accomplish noteworthy
vitality reserve funds by lessening lighting vitality costs and related cooling vitality costs.

2.3. Day light recreation analysis
Daylight recreation (stimulation) is a method to foresee the measure of daylight going into the room
in a pre - arranging stage itself. In specific cases, it might even propose an adjustment in the plan of
structure. Reenacted sunlight estimation, which gauges sunshine quality levels turned out to be more
exact on account of utilizing worldwide measurements set up by different day lighting experts [1].
Sunlight factor is one of the measurements used to survey day lighting execution. It is characterized
as the proportion between the inside illuminance in a structure at one point and the outside flat
illuminance [2]. Numerous planners, while finding the light reenactments helpful as a learning
strategy, and for creating boundaries, for example, room arrangement, entryway and window sizes,
and surface reflection examines, are reluctant to rely upon it when settling on official conclusions on
the visual viability and stylistic nature of a specific plan proposition. So as to get the advantages of
reenacted process, the reenactment results ought to be utilized as the primary device for the plan, as
opposed to utilizing it toward the finish of configuration process [3].
The reenactment procedure can't be assessed by utilizing just one sort of programming, it is a mind-
boggling stream of work which starts from causing a 3D dynamic model that to can be adjusted without
reenacting the 3D model inevitably, trailed by interfacing it with approved reenacted apparatus to
guarantee the right examination results [3,4]. These outcomes are assessed to give us a numerical and
visual criticism subsequent to being prepared by recreating enhancement which naturally changes
various factors so as to show signs of improvement recreation results which in the end determines an
advanced arrangement [8]. Energy efficiency and indoor condition have gotten progressively
significant in building structure. Building engineers, specialists and originators are stressing to deliver
structures with lower energy utilization and higher energy efficiency productivity. The measure of
energy a structure devours for its activity and support is practically proportional to measure of its
carbon outflows [6]. This consideration regarding energy execution has prompted developing
mindfulness that, so as to accomplish low energy structures with good indoor atmosphere, the creator
must know about the results of basic plan choices in the underlying phases of configuration process.
Keeping up the solace level of a structure through artificial warming or cooling represents a significant
segment of the total energy utilization [9]. Artificial lighting expends electrical vitality as well as adds
to the cooling loads because of the warmth created by different force devouring and lighting
apparatuses. The most financially savvy decrease in energy utilization happens during the plan
procedure, by executing plan methodologies, for example, direction of the structure, massing of the
assembled structure, utilizing energy proficient structure materials, photovoltaic frameworks, normal
sunshine, and concealing gadgets, planners can fundamentally lessen warm heaps of a structure Even
however sunlight is perceived as a powerful way to diminish the artificial lighting necessities of
structures, sunshine is as yet an underexploited regular asset[7]
Figure 2: Analysis of Building

3. Ecotect software

Ecotect is a feasible and sustainable design investigation programming which is a thorough idea to detail practical structure configuration device. It offers a wide scope of recreation and building energy investigation usefulness that can improve execution of both existing structures and new structure plans. It permits architects to recreate and examine the structure execution from the soonest phases of reasonable plan [5]. It joins the investigation capacities with an intelligent showcase that gives scientific outcomes straightforwardly inside the setting of the structure model. It has a very easy to user interface that permits fabricating and making 3D models effortlessly. The Ecotect was for the most part utilized during calculated stage and structure advancement period of the venture. It gives pertinent data about different examinations, for example, light investigation, shadow examination, warm properties, concealing gadgets, and solar radiation, shadows and reflections so on [6].

Figure 3: Daylight simulation in Ecotect software
4. Methodology of day light analysis
The primary goal of this examination is to know how Ecotect Daylight recreation investigation improves the energy efficiency and performance of a structure contingent upon its direction, shadow, material reflection and so forth.

Planning and drafting and extruded in AutoCAD programming and afterward exported into Ecotect. Building data for example, site area, direction, elevation, wind investigation and landscape were imported to the model [1]. Solar examination and Sun way investigation will give us a further developed calculation which is completely coordinated with Ecotect. The circulation of sun-based radiation can be pictured and evaluated for any date and, time and legitimately show the outcomes on the 3D model [3]. The intuitive sun way apparatus inside Ecotect permits the sun way to be envisioned to contemplate the effect of common light and shadows on the outsides and insides of the task at any area [7]. This instrument is completely coordinated with Ecotect and can be utilized to make sunlight-based examinations for any second in time, notwithstanding any predetermined time run. The incorporated Energy Analysis has been improved in Ecotect to support more definite structure components performed utilizing Green Building Studio, and to figure absolute energy use and cost on a yearly, month to month, day by day, and hourly premise, utilizing a worldwide database of climate data [5].
5. Method

5.1. Proposed Solution

Making use of Ecotect software modeling of an office building, (located 28.600° N, 77.200° E) is done. Measurements of the office are taken and the orientation of the room, material of the wall, floor, and windows are noted which is then used for the modeling. The dimensions of the office chamber are 5m * 3 m * 3m. Two ‘fluoro lamp strip’ units of 40w are installed, in which case the illumination level in the office is to be 250 lux. Window dimensions are 1.5m *1.5m. Height of the work desk is 1m. Working hours in the office are taken between 8 am to 6 pm.

5.2. Software Implementation

Lighting analysis is done and daylight factor, electric and daylight levels are calculated using this software. This analysis is done without using any blinds. Looking at all these factors, optimum orientation and design is suggested which would save maximum amount of energy.

Figure 4: Modelling in Ecotect software

Figure 5: Shadow analysis of an office building
The above figures show the daylight light output in the office building. Different color shows that daylight factor in the room are in the range of 2.8% to 22.8 % and the highest being near the window.
6. Results and discussion

Modeling of the office is done in Ecotect software and accurate measurements of the room and its position are taken.

6.1. Shadow analysis for the structure

Shadow investigation show the point by point day lighting examination and execution of the structure hourly.

6.2. Distribution of solar rays for building

To dissect the conveyance of sunlight-based beams inside the rooms, the structure is selected and being investigated in ECOTECT [8]. The shadow examination and sunlight-based investigation expresses that the appropriation and impression of sun-oriented beams diminishes with the time and the impact of shadows on the chose room can be seen in any event, when there are no sun-based beams or its appearance from the openings and the surface that are going through the math of the room. So as to acquire more noteworthy efficiency and entrance of sunlight-based beams and limit the impact of shadows on building, the calculation is recreated, and the whole investigation has been done to assess a similar procedure. So, with these discussions, recommend that, successful use of day lighting can be accomplished by the mathematical shape, direction, material reflection and by limiting the shadows on the structure because of different structures in the region, subsequently expanding the energy efficiency and making a superior living condition to the inhabitants [8].

6.3. Light Analysis

An Office, without using the blinds daylight level varies between 2.8% to 22.8% depending on the distance from the window since daylight reaches different portions of the room. Thus, depending on the percentage daylight level in the room lighting fixtures can be positioned to illuminate the room evenly. Daylight level is observed to be in the range of 280-2380 lux. Electric lighting level is in the range of 12-312 lux which is calculated without the use of blinds. The overall light level varied from 320-2420 lux. Thus, a considerable amount of outside light can be controlled by incorporating proper design parameters to have more comfort inside the building.

7. Conclusion

It has been plainly obvious from the total examination that the Day light reenacting has specially to do with the calculation and direction of the structure. Ecotect is unique in relation to different examination apparatuses, that it focuses on the most punctual phases of building structure, when straightforward choices may affect the conclusive outcome of a venture. Light analysis shows that spaces having different access to daylight have varying daylight factor, daylighting level, electric and overall lighting level. The examination ends up being commendable, simple and profoundly practical in arranging phases of development ventures [1].

It can likewise be utilized for existing structures where slighter change can be made. This programming can without much of a stretch recognize the total sun way and shadow investigation of every single room of a structure [2]. It has been ending up being commendable, while considering the vitality productivity of a structure. In this way, this recreation programming's could change the situation of Energy productive structures. These outcomes would augment the energy efficiency for future use by considering the critical green structure viewpoints for estimation [5].

The structure models for planning and building new situations ought to be founded on the assessment
of existing ones, and altered when fitting with regards to the plan procedure. Quick advancement and issues with the energy deficiency, cause ecological structures and economic advancement to have become the new focal point of the general public. It is earnest to investigate more natural arranging techniques what's more, systems towards building exhibitions [4]. Planners should give full thought to different ecological energy sparing techniques in the idea configuration by dissecting and afterward offer elective structures[6]. Programming like Ecotect encourages them to be touchy to common state of a spot where the structure would be assembled.

By thinking about nature as significant expected wellspring of vitality, grant winning structures would turn out to be more environmental, expend lower vitality, and at last make better living condition [7]. Later on, it is noteworthy to guarantee that the structure arranging stage to be logical to make a more agreeable, ecofriendly and energy sparing working condition. As better place has various atmospheres, temperature, furthermore, rain water density, the worldwide act of green structure and application, ought to likewise think about the nearby insight setting. This is required to develop understanding and characterize the neighborhood environmental information for additional exploration [9].

![Energy efficiency building](image)

**Figure 10:** Energy efficiency building

8. References

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