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A Study On the Effective Use of Daylighting System for Existing School Building in Pune

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***Abstract*: Current trend in architecture towards green building involve sustainable design, i.e. conservation of resources, energy efficiency, passive design, renewable energies, etc. and healthy environment for people (air quality, non-toxic materials and occupant's health). However, in school buildings have large rooms are common that almost depends upon electricity for lighting. Schools can effectively reduce energy use as schools are functional during daytime. Schools have compact budgets and rising energy cost adds additional strain to already compact budget. To increase the use of natural light for illumination, particularly in school building, effective use of daylight is important. According to a study by the Heschong Mahone Group, the students who receive the most natural light are 18% better in performance than those with the least natural light. The objective of this paper is to study daylight techniques that can be used effectively in existing school building particularly in Pune city only. In this context, it is becoming well known that glazing systems in combination with daylight and shading strategies along with the mixed mode or natural ventilation systems are require to achieve effective use of daylight in existing school building which give the psychological comfort for occupants. This research is a step getting an overview of the study of effective use of daylight system in existing school building. Case studies have been carried out in order to understand the topic. Comparative analysis of different case studies on the parameter's materials & strategies used has been carried out.**

***Keywords*: Daylight, School building, Daylighting design.**

1. Introduction

By the effective use of daylighting techniques in existing school building, dependency on electricity for illumination can be reduced also quality of light inside classroom can be improved. Natural light improves students' performance compared to artificial light. Though daylight is good, it also produces glare which makes occupants uncomfortable to use the space. Students spend most of their time inside classroom, where physical conditions influence their well-being and, therefore, their performance. An environment with uncomfortable thermal and visual conditions and with elements of psychological discomfort decreases the well-being and endanger the health of students. It is also important to communicate with the indoor environment, as well as a contact to the outside and sufficient use of day-light enhances user comfort and satisfaction. For this reason, windows and shading strategies are strongly favored in the classrooms. Moreover, the effective use of daylight offers many alternatives to improve the aesthetic of a building since light is an important design element.

2. Aim and Objectives

The aim of the paper is to study the effective use of daylighting system in existing school building. The main objective of this paper is to study daylighting techniques that can be used effectively in existing school building. The paper tried to draw simple recommendation that can be applied easily in existing school building. It is desired that these recommendations will develop the luminous environment of schools under daylight.

A. Need and Significance of Topic

The dependence of building sector on energy has been increasing. Schools are utilized during daytime only. So, there is a need for awareness about effective use of daylighting in school buildings, its benefits and the difference it can bring in the living. This research is a step taken towards that approach.

B. Scope & Limitation

This research will present a case study of school projects. The research will provide a broad overview of the effective use of daylight in existing school building and is focused on understanding the technologies. Study will limit to the existing schools' buildings as a typology in Pune city.

C. Research Question

What are the effective daylighting techniques/strategies that can be used in the existing school building to reduce the dependency on electricity for illumination?

D. Hypothesis

Effective use of daylight in school buildings is a need for the present-day scenario.

3. Methodology

Following method will be employed in conducting this research. Detailed Live and Bookcase studies of following structures will be carried out

1. Suzlon - One Earth, Pune
2. Avasara academy, Lawale Pune

3. Zilha parishad school, Hinjewadi Pune.

Collection of Data: The data collected will be put together and analyzed.

4. Literature review

A review of the development of daylighting in schools in May 2017 by Vincenzo Costanzo, this paper reviews the progress of daylighting in school buildings. It examines the publications that discuss daylighting design for school buildings in early 1874. It also traces the developments of the open-air school movement from 1900 up to the 1930s and describes research at the present day in the context of an emphasis on environmental factors defining healthy and comfortable buildings for education. The regulations and standards of lighting in schools in the different periods in Britain are summarized. The review reveals that there is a need to examine the relationships between the responses of school occupants and the quantity of daylighting. The conclusion of the paper gives an overall summary of daylighting in schools and identifies gaps in current knowledge. In addition, it provides the authors' opinions for future lighting research in schools.

A. Data collection

Suzlon – one earth, Pune
Following building component-
Office Complex & Corporate learning Centre.
Plot area - 45,392 sqm & Built up area - 70,865 sqm.

Capacity - 3000 employees, Ground plus two floors in a 10.4 acre. Spread over 10 acres, this sustainable and efficient design provides 75% of the work stations with daylight. All areas have operable fenestration permitting natural air and ventilation when possible. This approach resulted in lower, thinner and longer building shapes that increase the ratio of fenestration to volume, enhancing natural light and ventilation in a hot and dry climatic condition. In the Wind Lounge, steps leading into a water pool shaded by photovoltaic panels allowing filtered light in, as if through an ancient jaali. Maximum use of natural light into the work areas so as to improve productivity of occupants. There is 100% shading by external louvers on first and second floor.

Source:https://www.academia.edu/7711613/CASE_STUDY_SUZLON_ONE_EARTH_PUNE

Large glazed areas on North face to allow diffused light & window with vertical shades to cut off early morning and late evening sun, from North side.

Observation

Aluminum louvers act as a protective skin permitting daylight and cross ventilation.
100% shaded Glazing during summer (April-October)
Daylighting (more than 90% Daylit spaces)
Large glazed areas on North side.
Vertical fins used to cut off early morning and late evening sun.
High performance glazing is used. The exposed glass is 4mm.
Use of photovoltaic panels to allow filtered light
Use of operable fenestration to allow natural light.

B. Avasara Academy girl's school in Lavale, Pune

Year of Completion – 2016
Climate – moderate
Area of campus – 14200 sqm
This residence school campus comprises of seven similar buildings, each with classrooms on level 1 and 2, and student dormitory and faculty residences on level 3 and 4.
Capacity - 600 female students.

Source: https://www.designboom.com/architecture/case-design-transsolar-avasara-academy-lavale-india-04-28-2017/

Bamboo shading wraps two facades of the building, which are partially open and close.

Observation

Large glazed area to receive daylight inside classroom. Classrooms on the periphery of the exhaust cavity which cuts down the need of the electricity for lighting. Climatic responsive massing, strategic program placement, and the use of locally sourced bamboo shades/screens to avoid glare; these are all components that allowed the building to use maximum daylight. The building achieves a pleasant internal condition without the use of any mechanical system despite the warm and humid western climate of India. Deep verandas, bamboo screens and cantilevered ceiling tiles prevent the interior from being overheated by direct sunlight. To protect building facade, form direct sunlight, bamboo is used.

C. Zilha Parishad school, Hinjewadi.

Year of completion: 2011
Climate – Moderate
The ZP school, facility comprises of principal office, staff rooms, hall, computer lab, library.

Operational schedule – 6 days and 10 hours
Area of the building: 1500m²
Capacity - 1545
Building height - G+3

Observation:
Trees -Shade external walls, in the afternoon.

Classrooms are around courtyard provides adequate daylight during operational hours. G+3 storey building. Minimum height above the ground level to restrict exposure to external conditions. Steel panel windows on south and north direction on ground floor and FRP mint green color sheets used as a paneling material for window on 1st ,2nd & 3rd floor.

Entrance is on East side & buildings longer axis facing south. Proper orientation also helps to receiving natural light. The orientation of building ensures minimal need to use electricity for lighting purposes. Diffuse light is available from the north throughout the year. Projection of slab provides shade to the south facing window and chajja provides shade to the north side window. Trees are planted in courtyard to shade external walls, in the afternoon.

Table 1
Zilha parishad school, Hinjewadi, Calculation of WWR

Facade orientation	Window area in SQM (L x B)	Wall area in SQM (of the respective orientation)	WWR
North side	76.5	346.5	0.22
South side	37.8	346.5	0.109
East side	21.6	99	0.22
West side	10.8	99	0.12
Total	146.7	891	0.164

Table 2
Materials used for Window panels in building

Panel type	Visual transmittance (%)	Area where it is used
Mild steel panels	0	Ground floor window
Mint green FRP	0	1st, 2nd, 3rd floor

5. Finding and Proposal

In the case of ZP school, as the longer axis of building facing North South direction and classes are located around courtyard, so there is adequate daylight available and diffuse light is available from the north throughout the year. Overall WWR is less than ECBC standards (40%) & courtyard on south side is sufficient to provide adequate daylight.

Steel panel windows on south and north direction on ground floor and FRP mint green color sheets used as a paneling material for window on 1st ,2nd & 3rd floor. Steel panels & FRP panels can be replaced with high performance glass to receive maximum daylight. Vertical fins can be provided to cut off early morning and late evening sun, from North side. Light shelf can be provided on north as well as south facing wall for enhancing daylighting.

6. Conclusion and recommendation

Achieving effective daylight in school building can be challenging due to inconsistent nature of available daylight. However, integration of daylight in school building provides some attractive benefits. Shading system can be extremely effective but choice of control strategy is completely depending on need of the space. The different case studies have helped to understand how they use the various materials and strategies to use effective daylight in school building. This research is a small step in understanding the study of effective use of daylight in existing school building and to reduce the dependency on electricity.

References

[1] N. L. Nik Ibrahim & S. Hayman, "Daylight Design Rules of Thumb," Conference on Sustainable Building South East Asia, 11-13 April 2005, Malaysia.
[2] Shruti Deshpande Kulkarni, "Case Study – Suzlon One Earth, Pune, 2009
[3] Srikonda R, "Window Sizing for Daylighting for Non-Air Conditioned Buildings in Andhra Pradesh, India," in Journal of Architectural Engineering Technology., J Archit Eng Tech, Vol 7(1), Jun 26, 2018.
[4] www.teri.org.
[5] Energy conservation building code https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017.pdf
[6] Erik Hinds, "v. Can Classroom Lighting Affect Testing Scores, July 28, 2015
[7] Mária Ferenčíková; Stanislav Darula, "Utilization of daylight in school buildings," 13-16 Sept. 2016.

Table 3
Data analysis

No.	Parameters	Suzlon one earth, Pune	Avasara Academy girl's school in Lavale, Pune	Zilha Parishad school, Hinjewadi
1	Climate	Moderate	Moderate	Moderate
2	Year of completion	2009	2016	2011
3	Area	70865 sqm	11148 sqm	3000 sqm
4	Operational schedule	9hrs / day	12 hrs/day	10 hrs/day
5	Building orientation	East-South & North-West	Buildings are placed in such a way that to receive max daylight	Longer axis of building facing North South
6	Window and paneling materials	High Performance Glass	Large glazed window for daylighting	Windows with steel panel & FRP
7	Courtyard	Daylight optimization made possible through glass cylinder	Classrooms are around centrally located exhaust cavities.	Daylighting possible through courtyard and window if windows are glazed
8	Shading strategy	Open courtyards provided	wooden shades in combination with overhangs & bamboo provides shading to the mostly exposed building.	Classrooms are around courtyard.
9	Strategies to use maximum daylight	100% shading by aluminum louvers	Large glazed area to provide daylight	Vegetation-Trees and plants shades external walls in the afternoon.