

Impact of Day Lighting in Residential Building: A Case Study of Indore, India

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Abstract—Day lighting in residential building has various psychological and physiological advantages, especially contributing to visual comfort. A prime role in entering the day lighting into a residential building is windows, setbacks and the surrounding of a building. However in universal, multiple spaces in a building is undergo from insufficient day lighting due to inadequate window sizes or setbacks to archive proper visual comfort. Analysis. For this cause, day lighting in west side oriented residential building located in Indore (India) was studied.

The day lighting was calculated using a lux meter calculator at different timings of the day at different spaces/rooms of the building. Additionally the natural illumination level of different rooms were examined against standard illumination levels given in “National Building Code of 2005” and “Neufert's Standards”. **Findings**— Areas inside building undergo from inadequate day lighting. **Improvement**— Build on the day lighting analysis, design proposal for window sizes with instance to the particular building setbacks were suggested.

Index Terms— Day Lighting, Residential Building

I. INTRODUCTION

Daylighting is the controlled acceptance of natural light into a building to minimize electric lighting and conserve energy. Certain consciousness is given to daylighting while designing a building when the aim is to maximize visual comfort or to conserve energy. Energy conservation can be achieved or to minimize the use of artificial (electric) lighting or from passive solar heating. The amount of openings, its orientation, outside obstruction & positioning of building disturb the inside illumination. Almost all of the energy utilization happens during the building’s operational phase for heating, cooling & lighting purposes.

Windows play a significant role not only in admitting the daylight into the building’s interior but also as openings that provide view to the outside world. Window’s position, opening size, the room’s shape, depth and the colour of internal surface determine the interior daylighting. The calculation of daylight factors requires estimation of sky component, external reflected component and internal reflected component for clear design sky condition which is accepted as standard outdoor condition.

II. BENEFITS OF DAY LIGHT OF HUMAN BEHAVIOUR

There are various advantages of natural lighting in the design

- It makes us healthier in mind, body and spirit.

- It helps us heal, lifts physical and mental performance and productivity, and helps us reach our potential.
- It makes us happier in ourselves, and in the way we interact with others.
- Hospitals where less medicine is needed, where patients recover faster, where staff enjoy their environment.
- Schools where academic performance is raised, where better behaviour blossoms, where futures seem brighter.
- Workplaces where productivity is lifted, staff recruitment and retention increases, and the bottom line is boosted.
- New homes with lower heating costs and happier occupants.

III. CONTEXTUAL BACKGROUND

India makes some byelaws in context to building, in which the width of the setbacks is given, which is depends upon, width of the road, height of the building and the size of the plot. Although the day lighting factor is not considered. This is the biggest hindrance in admitting daylighting into the building.

TABLE I
 RECOMMENDED VALUE OF ILLUMINATION

Types of Interior/Activity	Recommended value of illumination in lux
Reading Area	200
Dining Room	100
Kitchen	200
Bedroom/Sleeping Area	100
Bathroom/Wash Area	100
Entrance/Living	150
Store	50
Changing Room	100
Circulation Area	50
Staircase	100

IV. WINDOW OPENINGS AND SETBACKS

Marginal offset or the setbacks are the space between the site boundary and the building line. Setbacks line are usually parallel to the plot line in which we do not construct any permanent structures as per the National Building Code of India 2005. As we cannot construct in setbacks so there is no hindrance in admitting the daylight into a building. Therefore

setbacks are the key element for daylighting. As we know that the sun travels east to west via south, so the illumination level of different rooms are different at different times. In morning the daylight is pleasant and bright, in afternoon it goes very harsh, and in the evening it goes dull.

The daylighting was calculated in the west side of the residential room with respect to the changing hindrance distance and the changing window sizes. It was found that the daylight is affected by the size of window and by the obstruction present. It was also found that the higher floor levels archived more daylighting in compare to the lower floor levels. Interior daylighting is indirectly proportional to the square of the distance from the obstruction. Although landscape elements also affect the amount of daylighting admitting in the room. Interior textures and finishes materials also affect the amount of daylight entering in the room. The small sill level maximize the solar gain while the higher sill level restrict the view of the exterior side Skylight provide better and uniform daylight in compare to side light, but the side light provides the better visual contact to exterior space. Around 27.59% of yearly savings can be archived by choosing the best orientation, optimum window size shading devices and optimum insulation thickness. Light selves can minimize the daylight admitting in the room. Shape and size of the window archive comfortable daylighting.

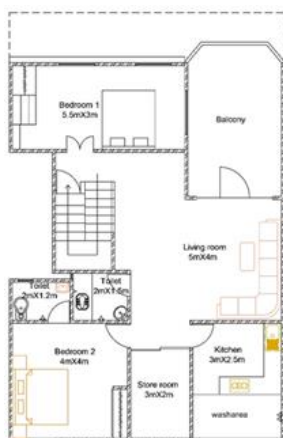


Fig. 1. Second floor plan

V. STUDY AREA

As we study above about the setbacks. The main challenge is to understood the variation of indoor daylighting due to orientation and the size if the window, building shape and sizes, the wall textures and wall color of the room.

1. Measurement methods:

As we all know the sunlight is more in summer season rather than the other seasons. So the study was conducted in July month of 2018. Only the second floor of the building is considered for the study. The illumination was calculated with lux calculator at the working table height while keeping the door closed. Every room was studied at different times of the day and this has been done at regular basis.

2. Building Profile:

The residence is located in the bairathi colony, Indore. The area of the plot is 136 sq.m and the ground coverage of the plot is 100 sq.m and the remaining area is setback area. The building contains two floor and the height of the building 8.70m. It is a row housing residential building with two sided roads. The setback from front side is 1.5 m and the remaining details like road distance, obstruction distance and the opening sizes are given in the Table-2.

TABLE II
SURROUNDING DETAILS

Orientation	Surrounding in metre	Setbacks in metre
East	Road(1.00)	0.00
West	Residence	1.50
North	Residence	1.00
South	Road(3m)	0.00

3. Openings:

In Table-3, the existing areas of the windows is compared against the required minimum opening sizes as given in the National Building Code of India 2005. Here we found that the areas in kitchen and in bedroom 1 is more than that the area recommended, and in bedroom 2 the area provided is less than the area is needed.

TABLE III
OPENING DETAILS

S. No.	Rooms	Area(sq.m)	Opening Provided (sq.m)	Opening Required (sq.m)
1.	Bedroom-1	16.5	3.9	1.65
2.	Bedroom-2	16	1.4	1.6
3.	Living	20	2.57	2.0
4.	Kitchen	7.5	3.0	0.75

4. Average Illumination Level:

TABLE IV
AVERAGE ILLUMINATION LEVEL

	Average Illumination of the day in lux	Illumination Provided in lux
Exterior	12028	9000
Bedroom-1	155	100
Living	85	150
Kitchen	126	200
Bedroom-2	45	100

VI. KEY OBSERVATION

1. Bedroom-1: It was found that the average illumination of the room is more than the recommended illumination. It was also found that the illumination is very harsh at 2:00-4:00pm and lesser during the remaining day.
2. Bedroom-2: The illumination in this room is comparatively very low than recommended illumination. The major portion of the room is in dark, we don't use that room without any artificial lighting even in the day time.
3. Living Room: It is almost the same as the recommended value given in National Building Code of India 2005. The illumination is good only at 10:00 to 4:00pm. The illumination level are more near the window than away from

the window. The major portion of the room is in dark.

4. Kitchen: The average illumination is found to be higher than the recommended values. It was noted that the size if the window is very large than the window is required.

VII. CONCLUSION

The study of the daylighting illumination in each functional spaces or rooms shows different majorly due to the variation in window sizes, orientation of windows, setbacks and the obstructions in the surrounding. Although the setbacks are in

accordance with the local building byelaws. Mainly the portion is have sufficient lighting accept in bedroom 2, and as a result it was found that the residence does not depends on the artificial lighting.

REFERENCES

- [1] National Building Code of 2005 and Neufert's Standards.
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