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A Case Study on Green Building Rating System for a Residential Building

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Abstract
Green buildings are designed to minimize environmental impact, improve resource efficiency, and enhance occupant comfort throughout the building life cycle. The Indian Green Building Council (IGBC) developed rating systems to evaluate the sustainability performance of residential and commercial buildings. These rating systems focus on sustainable site planning, water conservation, energy efficiency, materials and resources, and resident health and wellbeing. Green building concepts help reduce energy consumption, conserve water, minimize waste generation, and improve indoor environmental quality. They also support sustainable development by reducing carbon emissions and dependence on natural resources.
Keywords: *Daylighting; Energy efficiency; Green building; IGBC; Sustainability*

1. Introduction
The rapid growth of the construction industry has increased the consumption of natural resources, energy, and water, leading to environmental degradation and increased greenhouse gas emissions. Residential buildings consume significant amounts of electricity, water, and construction materials during their life cycle. To overcome these environmental challenges, green building concepts have become an important approach for sustainable development. Green buildings promote efficient resource utilization, reduced environmental impact, and improved indoor environmental quality through sustainable planning, construction, and operation practices. The Indian Green Building Council (IGBC) developed Green Home Rating Systems to encourage environmentally responsible residential developments. These rating systems evaluate buildings based on sustainable site planning, water conservation, energy efficiency, material and resource management, and occupant health and wellbeing. Sustainable strategies such as daylighting, natural ventilation, rainwater harvesting, wastewater recycling, energy-efficient systems, and waste management help improve building performance and reduce operational costs. These measures also enhance occupant comfort, thermal performance, and indoor air quality. Several researchers have highlighted the importance of green building rating systems in achieving environmental sustainability and resource conservation. Mahale and Khare (2021) explained that sustainable site planning and ecological preservation significantly reduce environmental degradation. Darko and Chan (2021) observed that efficient water management systems reduce dependence on municipal water supply and improve building sustainability. Hazem and Abdelraouf (2020) emphasized the importance of rainwater harvesting, greywater recycling, and low-flow fixtures in residential projects. Research by Shen et al. (2020) identified energy efficiency as one of the most important aspects of green building performance. Studies on passive design techniques, natural ventilation, and efficient building envelopes showed a significant reduction in operational energy demand. Researchers also observed that sustainable materials, recycled products, and low VOC materials improve indoor environmental quality and occupant comfort. Overall, green building rating systems provide an effective framework for promoting sustainable development, environmental protection, and healthier living environments. The methodology adopted in this study is based on the IGBC Green Homes Rating System Version 3.0 for evaluating indoor environmental quality in a 2BHK residential

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building. The analysis mainly focuses on three important parameters: daylighting, ventilation, and cross ventilation. These parameters play a major role in improving occupant comfort, indoor air quality, thermal performance, and energy efficiency in residential buildings. The calculations were carried out using room dimensions, window areas, openable areas, and airflow conditions obtained from the building floor plan. Regularly occupied spaces such as bedrooms, living rooms, kitchens, and dining areas were considered for analysis as per IGBC guidelines. The study evaluates whether the residential building satisfies the minimum requirements prescribed by IGBC for natural lighting and ventilation performance.

1.1. Methods 1: Daylighting Analysis

Daylighting is the controlled use of natural sunlight through windows or openings to provide sufficient indoor illumination, reduce artificial lighting demand, and improve occupant comfort. Proper daylighting helps in saving energy, improving indoor environmental quality, and enhancing the health and productivity of occupants[1].

The Daylight Factor Method was used for evaluating daylight performance in regularly occupied spaces.

The daylight factor was calculated using:

Daylight Factor=(Window Area×Visible Light Transmittance×Constant×100)/Floor Area

Where:

- VLT = Visible Light Transmittance of glazing
- Constant = 0.2 for wall windows and 1.0 for skylights

Process Followed

- Identified regularly occupied spaces such as bedrooms, living rooms, and kitchens.
- Measured floor area and window area of each room.
- Considered angle of obstruction from nearby structures.
- Calculated daylight factor using IGBC formula.
- Compared obtained values with IGBC criteria.

IGBC Credit Achievement

According to IGBC Green Homes Version 3.0:

- Minimum daylight factor of 1% is required for living spaces and bedrooms.
- Minimum daylight factor of 2% is required for kitchens.

The calculated results satisfied the IGBC requirements in all regularly occupied spaces.As shown in Figure 1 floor plan of 2bhk residential building as shown in Table 1 Regular Occupied Spaces

Credits Achieved:

1 IGBC Credit achieved for daylighting compliance.

1.2.Methods 2: Ventilation Analysis

Ventilation is the process of supplying fresh outdoor air and removing stale indoor air to maintain acceptable indoor air quality and thermal comfort. Proper ventilation reduces humidity, improves air circulation, and decreases dependence on mechanical cooling systems. The Openable Area Method was used for ventilation analysis.Ventilation was calculated using[2]:

Ventilation=Openable Area/Carpet Area

1.2.1. Process Followed

- Identified regularly occupied spaces.
- Measured carpet area of each room.
- Calculated openable window and door areas.
- Considered effective opening area for sliding windows (50% openable).
- Compared calculated ventilation percentage with IGBC standards.

1.2.2. IGBC Criteria

- Living spaces: minimum 8% openable area
- Kitchens: minimum 6% openable area
- Bathrooms: minimum 4% openable area

From the calculations, some rooms satisfied the ventilation requirements while some rooms did not achieve the required percentage[4].

1.3.Methods 3: Cross Ventilation Analysis

Cross ventilation is a natural ventilation technique in which fresh air enters through one opening and exits through another opening placed on the opposite or adjacent wall. This creates continuous airflow and improves thermal comfort. The Cross Ventilation Percentage Method was used to determine the percentage of regularly occupied spaces provided

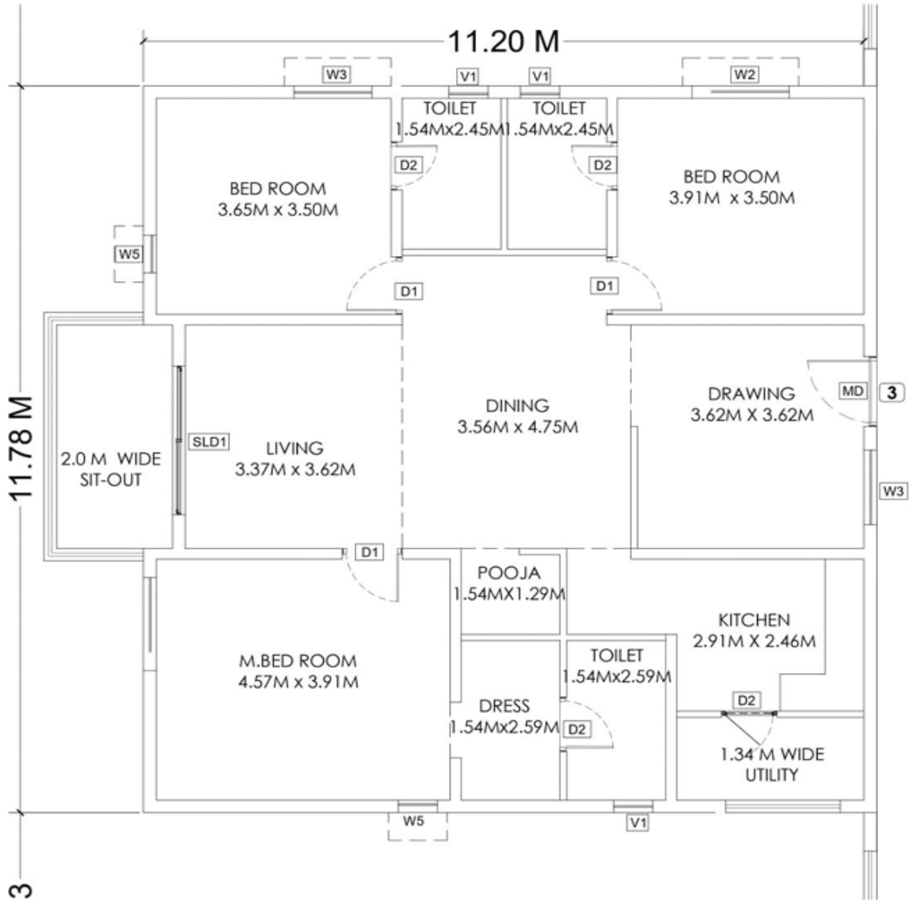

Figure 1 **floor plan of 2bhk residential building**

Table 1 **Regular Occupied Spaces**

Regular Occupied Spaces	Floor Area	Window Area	Vlt(%)	Constant	Daylight Factor	Achived	Criterai (Yes/No)
BEDROOM 1	12.77	1.812	0.6	0.2	1.70	1%	YES
BEDROOM 1	13.68	1.44	0.6	0.2	1.26	1%	YES
LIVING ROOM	12.19	5.04	0.6	0.2	4.95	1%	YES
M BEDROOM	17.86	2.532	0.6	0.2	1.70	1%	YES
KITCHEN	7.21	1.638	0.6	0.2	2.72	2%	YES

with cross ventilation[3].

1.3.1. Process Followed

- Identified rooms having at least two openings.
- Verified that openings were located on opposite or adjacent walls.
- Checked for obstructions near openings.
- Calculated percentage of carpet area provided with cross ventilation.
- Compared results with IGBC criteria.

The total cross-ventilated area achieved was approximately 87% of the total regularly occupied space area.

1.3.2. IGBC Credit Achievement

According to IGBC Green Homes Version 3.0:

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- 25% spaces = 1 Point
- 50% spaces = 2 Points
- 75% space = 3 points

1.3.3. Credits Achieved:

3 IGBC Credits achieved for cross

- 95% spaces = 4 Points

Since the project achieved 87% cross ventilation, it satisfies the >75% category.

ventilation. As shown in Table 2 Occupied space , Table 3 Floor Area.

Table 2 Occupied space

Occupied Space	Floor Area	Opening 1&2		Open Area 1	Open Area 2	Openable Window Area	Area From Igbc	Area From Plan	Criteria (Yes/No)
Bed Room 1	16.727	W3	W4	0.54	0.36	0.9	10%	5%	NO
Bed Room 2	14.5247	W3		0.54		0.54	10%	4%	NO
Living Room	14.282	SLD1		2.52		2.52	10%	18%	YES
Drawing Room	13.6644	W3		0.54		0.54	10%	4%	NO
Master Bed Room	18.9154	W3	SLD2	0.54	1.89	2.43	10%	13%	YES
Kitchen	10.5144	D2		0.819		0.819	8%	8%	YES

Table 3 Floor Area

Regularly Occupency Space	Floor Area	Opening	Satisfied Yes/No	Floor Area	%
Bed Room1	14.615	SLD2, W5	YES	14.615	87 %
Living, Dining, Drawing, Kitchen	52.8208	SLD2, SLD1, D2, KW2	YES	52.8208	
Master Bed Room	18.1305	W3, D1	YES	18.1305	
Master Bed Room 2	24.7401	W3, W1	YES	24.7401	
Bed Room 2	14.615	SLD2, W4	YES	14.615	
Multipurpose	12.765	W1, W5	YES	12.765	
Family Lounge	20.1656	SLD1	NO	0	
TOTAL	157.852			137.6864	

2. Result And Discussion

The residential building was analysed based on the IGBC Green Homes Rating System Version 3.0 by evaluating daylighting, ventilation, and cross ventilation performance. The results showed that the building incorporates sustainable design features that improve indoor comfort and energy efficiency. The daylighting analysis indicated that all occupied spaces satisfied the minimum daylight factor required by IGBC standards. Bedrooms and living spaces achieved more than 1% daylight factor, while the kitchen achieved more than 2%. Proper window design and room planning provided adequate natural lighting and reduced dependence on artificial lighting. The project achieved 1 IGBC credit for daylighting compliance. The ventilation analysis showed that the living room, master bedroom, and kitchen satisfied the required ventilation criteria, while some bedrooms and the drawing room did not meet the minimum requirement due to limited opening areas. The cross-ventilation analysis demonstrated effective airflow, with about 87% of occupied spaces receiving proper cross ventilation through openings on opposite or adjacent walls. This improved natural air circulation and thermal comfort. According to IGBC standards, the building achieved 3 IGBC credits for cross ventilation. Overall, the study highlights that proper daylighting and ventilation strategies improve building performance, occupant wellbeing, and energy conservation.

Conclusion

This study evaluated a residential building using the IGBC Green Homes Rating System Version 3.0 with focus on daylighting, ventilation, and cross ventilation. The results showed satisfactory daylighting performance and effective cross ventilation in 87% of occupied spaces, improving indoor comfort and reducing dependence on mechanical cooling systems. Although some spaces did not satisfy the required ventilation percentage, the overall building performance reflected effective sustainable planning. The study concludes that proper window design, natural ventilation, and efficient space planning contribute to energy conservation, better indoor air quality, occupant health, and environmental sustainability. The IGBC Green Homes Rating System provides an effective framework for sustainable residential development.

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