

Analysis of building performance with reference to Eco Samhita 2018 in Indore

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Abstract

In India, there was no code for building energy performance as of December 14, 2018. Due to changes in window material and operating system, building byelaws that related windows to floor area were also out of date. Therefore, there is a lot of room to raise awareness about building energy efficiency among regular people, potential home buyers, and builders. Ecology niwas Samhita 2018 gives architects the freedom to create energy-efficient buildings in their own unique ways and teaches how to break down a building into simply three categories. There are four criteria: WFR (op), which stands for openable window to floor area ratio; VLT value, which stands for visual light transmittance in relation to window to wall area ratio (WWR); U value of the roof; and RETV, which is for residential envelope transmittance value. This article explores these criteria in detail with relation to one block of the chosen apartment building Mapple Wood in Indore to assess whether it complies with the 2018 ENS code's required limits. After examining these four criteria, it was discovered that the shading of windows and the insulation of the top slab are two problems that should be dealt with scientifically during the design stage to enhance the building's energy efficiency.

Keywords — Openable window to floor area ratio, Residential Envelope Transmittance Value, SHGC, U Roof, Visual light transmittance, window to wall area ratio.

INTRODUCTION

There was no code for the building envelope of residential buildings in India until the "Eco-Niwas Samhita 2018" code, which was very recently (14 December 2018) introduced. In this code, the building envelope has been created to provide minimum building envelope performance standards to ensure adequate natural ventilation and day lighting potential, as well as to restrict heat gains for cooling-dominated climates and to limit heat loss for heating-dominated climates. The code gives designers the freedom to experiment and change crucial elements of the envelope, including as the type of wall, the size and type of windows, and the glazing and exterior shading options, in order to comply.

The minimum openable window-to-floor area ratio (WFRop) required by the code, which is set at 12.5%, ensures that buildings meet minimum performance standards for acceptable natural ventilation potential.

The code specifies a minimum visible light transmittance (VLT) for the non-opaque building envelope components in order to establish minimum building envelope performance standards for appropriate daylight potential.

The maximum residential envelope transmittance value (RETV) applicable to the building envelope (other than the roof) in a composite environment is 15 w/m², while the maximum u value for the roof is 1.2 w/m².

The area of Maple Woods is 15.67 acres. The location is situated on a master plan route with a proposed width of 30 meters that connects Dewas Naka to Pipliya Kumar village road, close to Rau By-pass. It is conveniently accessible from the northeastern outskirts of Indore.

METHODOLOGY

Four criteria—WFR (op), Visual light Transmittance in relation to window to wall area ratio, Slab U Value, and RETV Value—were used to assess the building's performance. Therefore, all of these factors will be calculated for the chosen structure to see if they fall within the parameters.

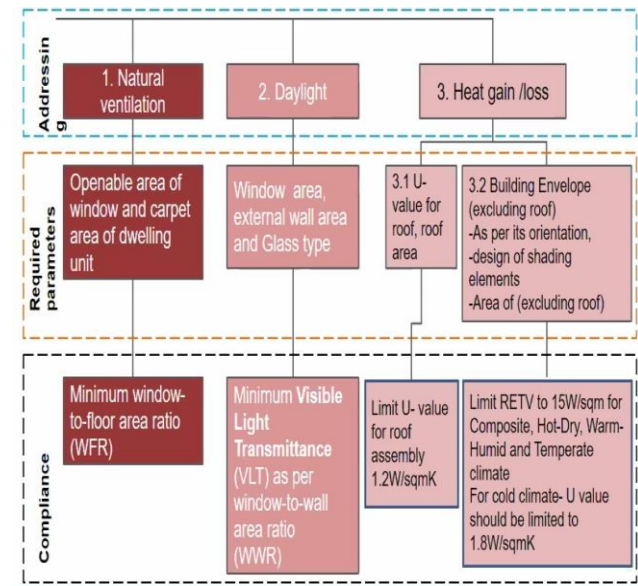


Figure 1: Flow chart for Methodology

Table 1: OPENABLE WINDOW TO FLOOR AREA RATIO

Details of Floor Area				
Flat No.	Space	Length (m)	width(m)	Total Area (sqm)
1&2	Living	5.00	4.87	24.35
	Kitchen	3.50	3.10	10.85
	Dinning	6.00	3.42	20.52
	Bed 1	3.35	3.96	13.27
	Bed 2	3.35	3.96	13.27
	Bed 3	3.65	4.57	16.68
	Bed 4	3.35	3.65	12.23
	Toilet 1	2.75	1.50	4.13
	Toilet 2	2.10	1.50	3.15
	Toilet 3	2.28	1.29	2.94
	Toilet 4	2.75	1.50	4.13
	Dressing	2.59	1.40	3.63
	store	0.84	1.07	0.90
	Total of Single unit			130.03
Total of 1 & 2				260.05
3&4	Living	5.00	4.80	24.00
	Kitchen	3.58	3.12	11.17
	Dinnin g	7.00	3.50	24.50
	Bed 1	3.30	3.96	13.07
	Bed 2	3.60	4.57	16.45
	Bed 3	3.30	3.66	12.08
	bed 4	3.30	4.42	14.59
	Toilet 1	2.75	1.50	4.13
	Toilet 2	2.10	1.50	3.15
	Toilet 3	2.28	1.29	2.94
	Toilet 4	2.75	1.50	4.13
	Dressing	2.59	1.40	3.63
	store	1.40	1.06	1.48
	Total of Single unit			135.30
Total of 3 & 4				270.61
Total floor area including all flats at a floor				530.66

Schedule of Openable Areas					
Type	Openin g area	Nos	Total opening area	Opening Percentage	Openable Area
W1(living)	6.30	4	25.2	66	16.63
W2(bed room)	3.15	4	12.6	50	6.30
W3(bed rooms)	4.41	8	35.28	66	23.28
W4	1.35	4	5.4	50	2.70
W5	0.72	4	2.88	50	1.44
V	0.54	12	6.48	90	5.83
D	1.89	4	7.56	90	6.80
Total					62.99
Openable Window-to-Floor Area Ratio (WFR op)					0.119
(In terms of percentage)(%)					11.87

Minimum WFR (op) should be minimum 12.5, hence this criteria does not comply with code.

Table 2: WINDOW TO WALL AREA RATIO

Apartment -Mapple Wood (Block A1) Nipaniya.							
Details of window				Details of wall			WWR
Wind ow Locat ion	Area of wind ows / doors (m ²)	Total Windo ws from all 10 floors	Total Area of Windows/ Doors	Length (m)	Height of all 10 floors (m)	Total Area (m ²)	
North wall							
Flat no. 1 and 3 bedroom	3.15	20.00	63.00	32.55	31.80	1034.9	0.07
Toile t venti lator	0.54	20.00	10.80				
Total window / door area			73.80				
East wall							
Flat no. 1,2, Living	6.30	20.00	126.00	29.57	31.80	940.33	0.32
Flat no. 1,2 - Bed rooms	4.41	40.00	176.40				
Total window / door area			302.40				
West wall							
Flat no. 3,4 , Living	6.30	20.00	126.00	29.57	31.80	940.33	0.32
Flat no. 3,4 - Bed rooms	4.41	40.00	176.40				
Total window / door area			302.40				
South Wall							
Flat no. 2 and 4 bedroom	3.15	20.00	63.00	32.55	31.80	1034.9	0.07
Toile t venti lator	0.54	20.00	10.80				
Total window / door area			73.80				
Average WWR of building =							0.79
Total wall area A (envelope)					3950.5		

As 6mm single clear glass is used for this project with VLT of 0.85 whereas minimum VLT required for WWR 0.2 is 0.27. Hence VLT criteria comply with code.

Table 3: U VALUE CALCULATIONS

Details of U value calculation (Slab)					
Slab Layers	Thickness (m)	Thermal Conductivity (W/m.K)	Thermal resistance (R = t / k)	U value (W/m²K) (1/R)	
Inner color	0.004	0.040	0.100		
Inner Plaster	0.012	0.721	0.017		
Slab	0.150	1.580	0.095		
Outer Plaster	0.018	0.721	0.025		
Brickbat Coba	0.150	0.811	0.185		
Mortar	0.010	0.719	0.014		
Rse(external)	Refer note below		0.040		
Rsi(internal)	Refer note below		0.170		
Total	0.344	4.592	0.645		1.549

Note- Rse is exterior surface film thermal resistance and Rsi is interior surface film thermal resistance. Their values are obtained as per Annexure 5, page no 22, table no 6 of Eco Niwas Samhita 2018, referred from BEE 2009, Building Code user guide.

Details of U value calculation (Wall)					
Walling Layers	Thickness (m) (t)	Thermal Conductivity (W/m.K) (k)	Thermal resistance (R = t / k)	U value (W/m²K) (1/R)	
Inner color	0.002	0.040	0.050		
Inner Cement Plaster	0.012	0.721	0.017		
Wall - Burnt ClayBrick (Density 1760 kg/m³)	0.200	0.980	0.204		
Outer Cement Plaster	0.018	0.721	0.025		
Outer Color	0.004	0.040	0.100		
Rse	Refer note below		0.040		
Rsi	Refer note below		0.130		
Total	0.236	2.502	0.566		1.768

Note- Rse is exterior surface film thermal resistance and Rsi is interior surface film thermal resistance. Their values are obtained as per Annexure 5, page no 22, table no 6 of Eco Niwas Samhita 2018, referred from BEE 2009, Building Code user guide.

As U value of slab is 1.549 which is greater than 1.2 hence this criteria does not comply with code.

Table 4: RETV CALCULATIONS

CALCULATION for term 1					
Orientation	Component	Area (m²) (A)	U Value (W/m²) (B)	Orientation Factor (u) (C)	(AxBxC)
North	Brick wall	1034.93	1.77	0.659	1207.175
	Wood				
South	Brick wall	1034.93	1.77	0.966	1769.546
	Wood				
East	Brick wall	940.33	1.77	1.155	1922.355
	Wood	16.17	2.91	1.155	
West	Brick wall	940.33	1.77	1.156	1924.020
	Wood	16.17	2.91	1.156	
Total (term 1)					6931.83

CALCULATION for term 2					
Orientation	Component	Area (m²) (A)	U Value (W/m²) (B)	Orientation Factor (u) (C)	(AxBxC)
North	windows	73.80	5.64	0.659	274.297
South	windows	73.80	5.64	0.966	402.080
East	windows	302.40	5.64	1.155	1969.894
West	windows	302.40	5.64	1.156	1971.600
Total (term 2)					4617.871

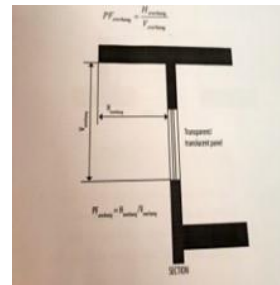


Figure 2: Projection Factor

CALCULATION OF SHGC	
PF overhang =	$\frac{H_{overhang}}{V_{overhang}}$ = 0.45/1.2 = 0.375
(Note- From PF overhang SHGC is obtained from table 11, page 31, Econiwas Samhita 18)	

CALCULATION for term 3					
Orientation	Component	Area (m²) (A)	Equivalent SHGC (B)	Orientation Factor (u) (C)	(AxBxC)
North	windows	73.80	0.86	0.659	41.825
South	windows	73.80	0.754	0.966	53.753
East	windows	302.40	0.797	1.155	278.370
West	windows	302.40	0.796	1.156	278.261
Total (term 3)					652.210

$$RETV = \frac{1}{A_{envelope}} \times \left[\begin{aligned} & \left\{ a \times \sum_{i=1}^n (A_{opaque_i} \times U_{opaque_i} \times \omega_i) \right\} \\ & + \left\{ b \times \sum_{i=1}^n (A_{non-opaque_i} \times U_{non-opaque_i} \times \omega_i) \right\} \\ & + \left\{ c \times \sum_{i=1}^n (A_{non-opaque_i} \times SHGC_{eq_i} \times \omega_i) \right\} \end{aligned} \right]$$

\longleftrightarrow Term 1 \longleftrightarrow Term 2

$$RETV = 1/A_{envelope} [\{ a \sum (A_{opaque} \times U_{opaque} \times u) \} + \{ b \sum (A_{non-opaque} \times U_{non-opaque} \times u) \} + \{ c \sum (A_{non-opaque} \times SHGC_{eq} \times u) \}]$$

\longleftrightarrow Term 3

A envelope calculated	3950.51
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1/A envelope	=	0.000253132
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Calculation considering values of constants a, b, c for composite climate

Constant	Value of Constant (1)	Output of term 1,2,3 (2)	(1) x (2)	Remark
a	6.06	6931.838994	42006.9443	Term 1
b	1.85	4617.870696	8543.060788	Term 2
c	68.99	652.2096816	44995.94593	Term 3
Total (term 1+term2+term3)			95545.95102	(Addition of all terms)
RETV	=	0.000253132	X	95545.95102

RETV	=	24.186
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As the value of RETV is 24.18 w/m² which is greater than 15w/m² hence this criteria of code is not complied.

CONCUSION-

With regard to the examined building, it is therefore evident that the value of VLT is within the ENS code's specified limit, making this criterion complaint. However, aside from VLT, the other three criterion—WFR (op), U Roof, and RETV—do not correspond to the ENS code's required limit. WFR (op) is very close to the permitted limit for each of these three criteria. It is advised to insulate the roof with insulation and shade windows appropriately in order to meet the other two requirements. A RETV value of less than 15 is needed to prevent excessive heat gain inside the structure, which in turn lowers the demand for mechanical cooling.

Table 5: Conclusion

Sr No	Requirement	Calculated	Criteria by Code	Status	Remark
1	WFR (op)	11.87	Maximum 12.5	Non-Compliant	11.87 < 12.5
2	VLT %	85	Minimum 27	Compliant	85 > 27
3	U roof	1.55	Maximum 1.2	Non-Compliant	1.55 > 1.2
4	RETV	24.19	Maximum 15	Non-Compliant	24.19 > 15
only 1 out of 4 criteria are compliant and 3 does not comply with ENS Code 2018					



Figure 3: Typical Floor Plan, Maple Wood, Indore

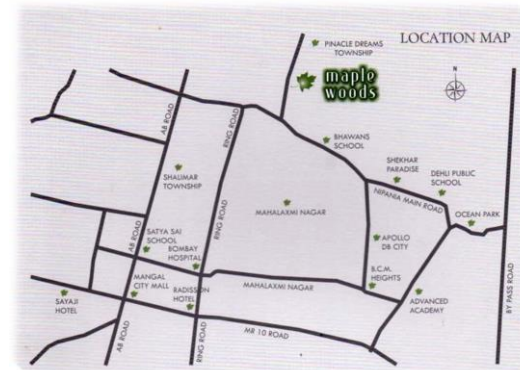


Figure 4: Location Map Maple Wood, Indore



Figure 5: Maple Wood, Indore

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