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

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Abstract

Till 14 Dec 2018 there was no code in India for energy performance of building. Rule related windows in building bye laws with respect to floor area were also outdated due to transformation in windows material and operating system. Hence there is a great scope to increase awareness about energy efficiency of building among common people, potential house owners and builders. Eco-niwas Samhita 2018 offers flexibility to Architects to design energy efficient building in their own way and explains to analyze building into only Four criteria which are WFR (op) meaning Openable window to floor area ratio, VLT value meaning Visual light transmittance with reference to window to wall area ratio (WWR), U value of Roof and RETV meaning Residential Envelope Transmittance Value. This paper discusses about these criteria with specific reference to one block of selected Apartment building Mapple Wood in Indore to verify its compliance with prescribed limit with respect to ENS code 2018. After analyzing these four criteria it was observed that Shading of Windows and insulation of top slab are two issues which need to be addressed scientifically at design stage to improve energy performance of building.

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

INTRODUCTION

In India, there was no code for building envelope of residential buildings until the recently (14 December 2018) launched code, "Eco-Niwas Samhita 2018". In this code building envelope has been prepared to set minimum building envelope performance standards to limit heat gains for cooling dominated climates and to limit heat loss for heating dominated climates, as well as for ensuring adequate natural ventilation and day lighting potential. The code provides design flexibility to innovate and vary important envelope components such as wall type, window size and type of glazing and external shading to windows to meet the compliance.

The code sets minimum building envelope performance standard for adequate natural ventilation potential by specifying minimum openable window-to-floor area ratio (WFRop) as 12.5%.

The code sets minimum building envelope performance standard for adequate daylight potential by specifying minimum visible light transmittance (VLT) for the non-opaque building envelope components.

Maximum value of residential envelope transmittance value (RETV) for building envelope (except roof) applicable for composite climate is 15w/m^2 and maximum u value for roof specified as 1.2 w/m^2

Maple Woods spreads across 15.67 acres. The site is located on a proposed 30 meters wide master plan road near Rau By-pass at Pipliya Kumar village road and connected to Dewas Naka. It is located in the northeast side of suburbs of Indore and is easily accessible to Vijay nagar, the new business district. Indore falls under composite zone.

METHODOLOGY

The performance of the building was verified against 4 criteria which are WFR (op), Visual light Transmittance with reference to window to wall area ratio, U value of slab and RETV value. Hence all these criteria will be calculated for selected building to cross check whether they fall in prescribed limits.

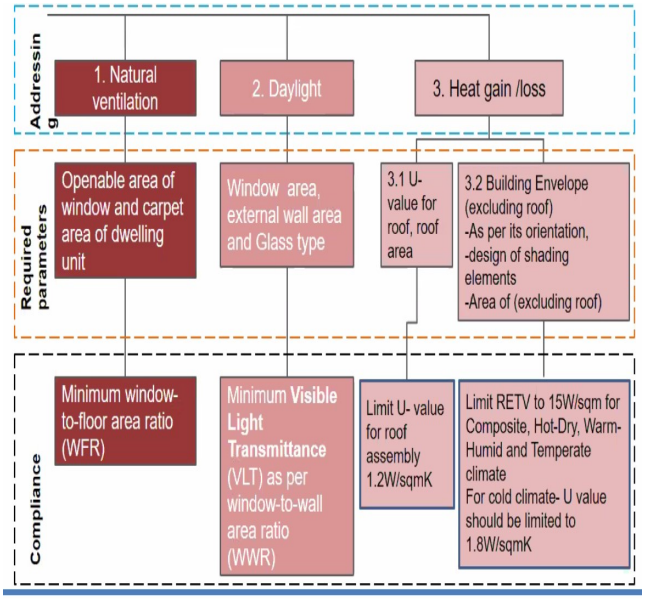

Figure 1: Flow chart for Methodology

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
	Dinnning	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	**Opening 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			
Window Location	**Area of windows / doors (m^2)**	**Total Windows from all 10 floors**	**Total Area of Windows/ Doors**	**Length (m)**	**Height of all 10 floors (m)**	**Total Area (m^2)**	**WWR**
North wall							
Flat no. 1 and 3 bedroom	3.15	20.00	63.00	32.55	31.80	**1034.9**	**0.07**
Toilet ventilator	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 - Bedrooms	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 - Bedrooms	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**
Toilet ventilator	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/m^2K) (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/m^2K) (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/m^3)	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 (m^2) (A)**	**U Value(W/m^2) (B)**	**Orientation Factor(ɯ) (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	54.348
West	Brick wall	940.33	1.77	1.156	1924.020
	Wood	16.17	2.91	1.156	54.395
Total (term 1)					**6931.83**

CALCULATION for term 2					
Orientation	**Component**	**Area (m^2) (A)**	**U Value(W/m^2) (B)**	**Orientation Factor (ɯ) (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**

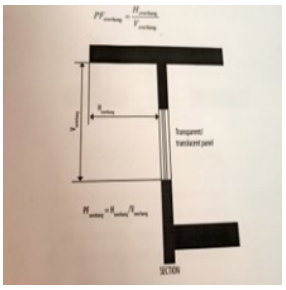

Figure 2: Projection Factor

CALCULATION OF SHGC

$PF_{overhang} = H_{overhang} / V_{overhang}$
$= 0.45/1.2$
$= 0.375$

(**Note-** From PF overhang SHGC is obtained from table 11, page 31, Econiwas Samhita 18)

CALCULATION for term 3					
Orientation	**Component**	**Area (m^2) (A)**	**Equivalent SHGC (B)**	**Orientation Factor(ɯ) (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**

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

Term 1 Term 2

RETV = $1/A_{envelope}$[{aXΣ({A_{opaque} X U_{opaque} X ɯ)}+{bXΣ($A_{non\ opaque}$ X $U_{non\ opaque}$ X ɯ)} + {c XΣ($A_{non\ opaque}$ X $SHGC_{eui}$X ɯ)}]

Term 3

A envelope calculated	3950.51

1/A envelope	=	0.000253132

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**

As the value of RETV is 24.18 w/m^2 which is greater than 15w/m^2 hence this criteria of code is not complied.

CONCUSION-

Thus with reference to the building analyzed it was clear that value of VLT is with in prescribed limit of ENS code hence this criteria is complaint but except VLT all other 3 criteria which are WFR (op), U Roof and RETV do not match with the prescribed limit ENS code. Out of these three criteria WFR (op) is very near to the prescribed limit. To fulfill other two criteria insulation treatment to roof and proper shading of windows are recommended so that value of RETV can be achieved below 15 in order to prevent excess heat gain inside the building and in turn reduce mechanical cooling load.

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					

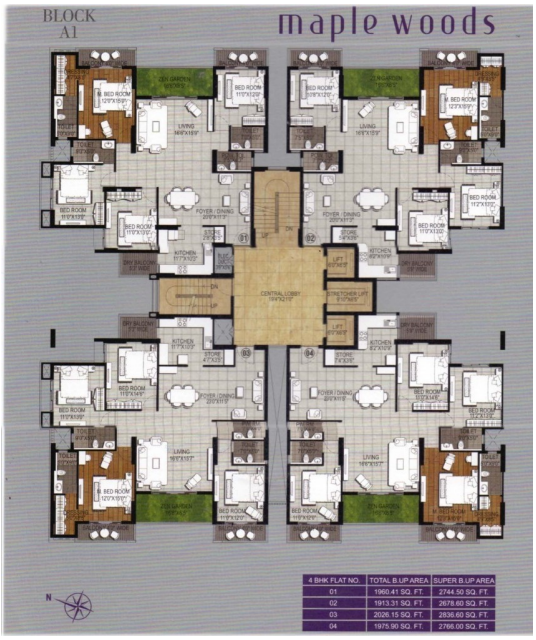

Figure 3: Typical Floor Plan, Mapple Wood, Indore

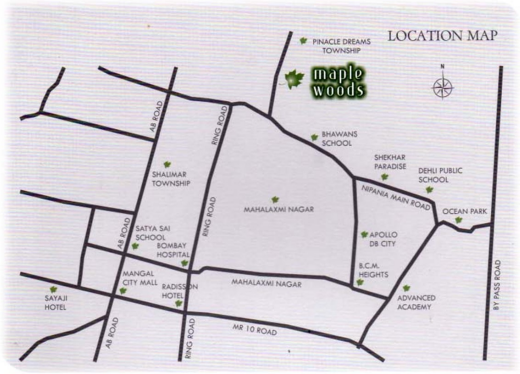

Figure 4: Location Map Mapple Wood, Indore

Figure 5: Mapple Wood, Indore

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