magicrete
magic behind happy homes

EVALUATING RETV OF BUILDING ENVELOPE FOR RESIDENTIAL BUILDINGS

A COMPARATIVE STUDY USING DIFFERENT WALLING MATERIALS

Author
Ar. Riddhi Gandecha
Founder, LaSelva Studio

Co-Author
Mr. Sourabh Bansal
MD, Magicrete

ABSTRACT

In India, there was no code for the building envelope of residential buildings until recently; the Government of India, along with the **Bureau of Energy Efficiency**, has drafted a code, **"Eco-Niwas Samhita 2018".**

This paper aims to compare different building envelope systems to check their compliance with the code provisions in different geographical regions of the country and help choose the right walling material for a house with a thermally conducive indoors. The RETV calculations only involve the external envelope of the building, including doors, windows, shading due to projections.

Magicrete appointed La Selva Studio (Ar. Riddhi Gandecha, Green Building Consultant), to conduct a study to analyse and **compare the impact of different walling materials on indoor thermal comfort by evaluating the RETV** values. Materials compared include**, AAC Blocks, RCC Shear Wall & Red Clay Bricks**.

Under this code, the maximum permissible Residential Envelope Transmittance Value (RETV) for the building envelope for four climate zones, namely, **Composite Climate, Hot–Dry Climate, Warm–Humid Climate, and Temperate Climate, is defined as 15 W/m².**

RETV is the net heat gain rate (over the cooling period) through the building envelope of the dwelling units, divided by the area of the building envelope of the dwelling units (BEE, 2018).

Climatic zone segregation and city selection in climatic zones

Climatic Zones	Cities
Composite	New Delhi, Hyderabad, Ranchi, Jaipur
Hot and Dry	Surat, Ahmedabad, Jodhpur, Aurangabad
Warm-Humid	Mumbai, Kolkata, Chennai, Pune
Temperate	Bengaluru

INTRODUCTION

ECO-NIWAS SAMIHITA

In India, the residential buildings' floor area is estimated to double (from 16.0 billion m2 to 31.6 billion m2), and the residential energy consumption is estimated to triple from (246 TWh/y to 748 TWh/y) between 2017 and 2030 (NITI Aayog, 2015). About 20 million new affordable homes in urban areas were planned under Pradhan Mantri Awas Yojana (PMAY) between 2015-2022 (MoHUPA, 2015). Until 2017-18, approximately 8% of the dwellings had room air conditioners, which is anticipated to rise to 21% and 40% in 2027-28 and 2037-38, respectively. The room air conditioner stock in dwellings of 25 million units in 2017-18 is expected to rise to 96 and 345 million units in 2027-28 and 2037-38, respectively. (MoEFCC, 2018).

Eco-Niwas Samhita 2018 (BEE, 2018) is the new Energy Conservation Building Code for Residential Buildings (ECBC-R).

The purpose of Eco Niwas Samhita (ENS) is to provide minimum requirements for energy-efficient design, construction of buildings, energy efficiency operations, and optimal usage of electro-mechanical systems catering to meet human comfort requirements in the residential sector.

ABOUT THE PROJECT

Having been a **key proponent** of **Modern Methods of Construction in India, Magicrete**, over the last decade, has revolutionized the way walls are built with **its flagship product AAC Blocks**. Intending to further transform the construction process in the country, Magicrete has introduced the 3rd generation building construction technology (3D Modular Precast) wherein the building structure to be made is modularised into parts called Pods, which are manufactured & finished in a factory. These fully finished pods are then shipped to the site and assembled.

Magicrete won the Global Housing Technology Challenge (GHTC) organized by the Ministry of Housing & Urban Affairs (which saw participation from more than 150 construction technology providers from across the globe) to use the 3D Modular Precast technology to build **the Light House Project (LHP) in Ranchi** consisting of 1008 dwelling units in G+8 configuration.

Hon'ble Prime Minister Shri Narendra Modi laid the foundation stone of the project on January 1, 2021.

In this study we have considered LHP, Ranchi as a sample project to demonstrate the RETV for various combinations of material and climate zone.

Project Brief	
Location of Project	Dhurva, Ranchi, Jharkhand
Climate Zone	Composite
No. of DUs	1,008 (G+8)
Plot area	21,569 sq.mt.
Carpet area of each DU	30.27 sq.mt.
Total built up area	47,860 sq.mt

Materials Considered for the RETV Calculation –

1. **AAC Blocks**
2. **RCC Shear Wall**
3. **Red Bricks**

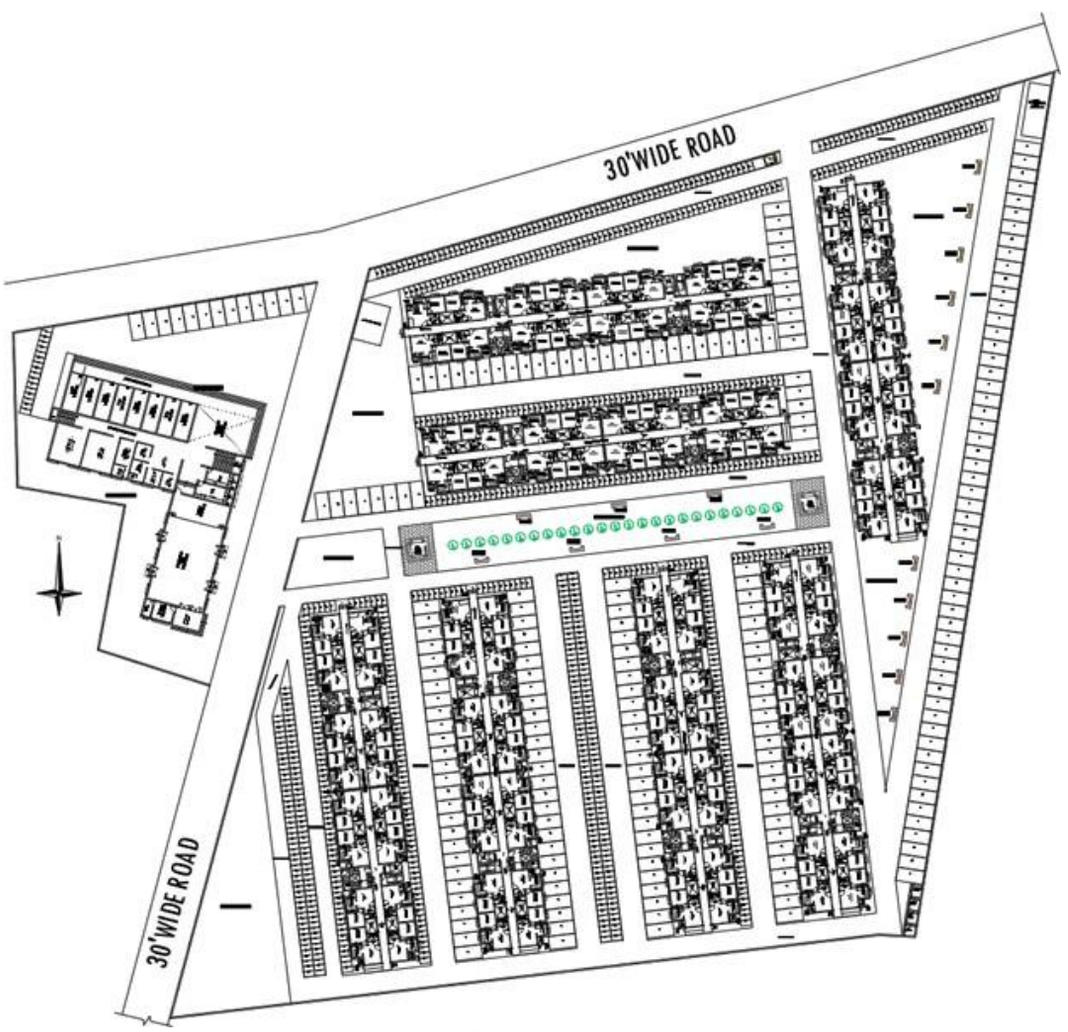
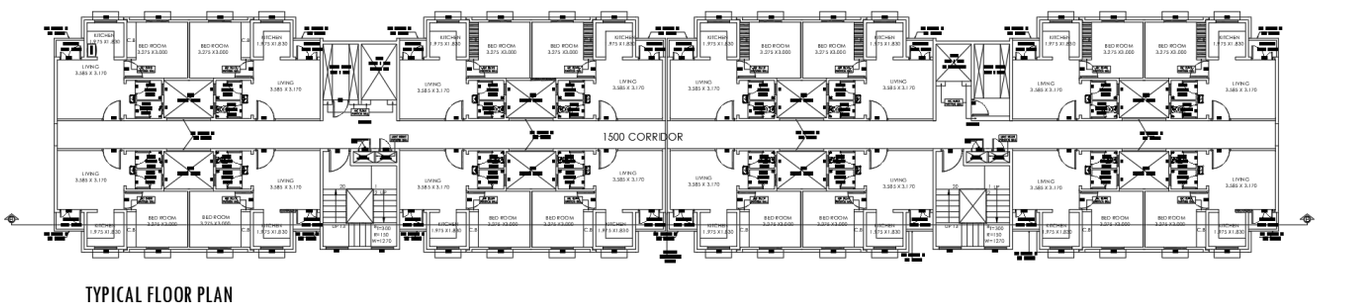
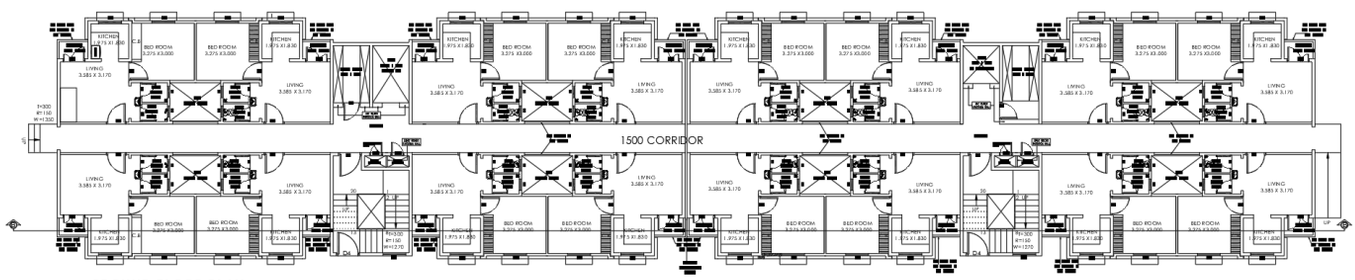


Figure 1. Site Plan

Typical building floor plans for Calculations



TYPICAL FLOOR PLAN



GROUND FLOOR PLAN

Figure 2. Plans

FRONT ELEVATION

Figure 3. Elevation

METHODOLOGY

Residential Envelope Transmittance Value (RETV) is the net heat gain rate (over the cooling period) through the building envelope of dwelling units divided by the area of the building envelope of dwelling units. The heat gains include conduction through the opaque building envelope components (e.g., external walls, opaque door, opaque windows, etc.), conduction through the non-opaque building envelope components (e.g., transparent / translucent panels in windows, doors, ventilators, etc.) and radiation through the non-opaque building envelope components. The unit of RETV is W/m^2.

The aim of developing the RETV formula was to be able to characterize heat gains from the building envelope in a simple way to estimate sensible cooling loads. The key steps taken for the development of RETV are shown in Figure 4.

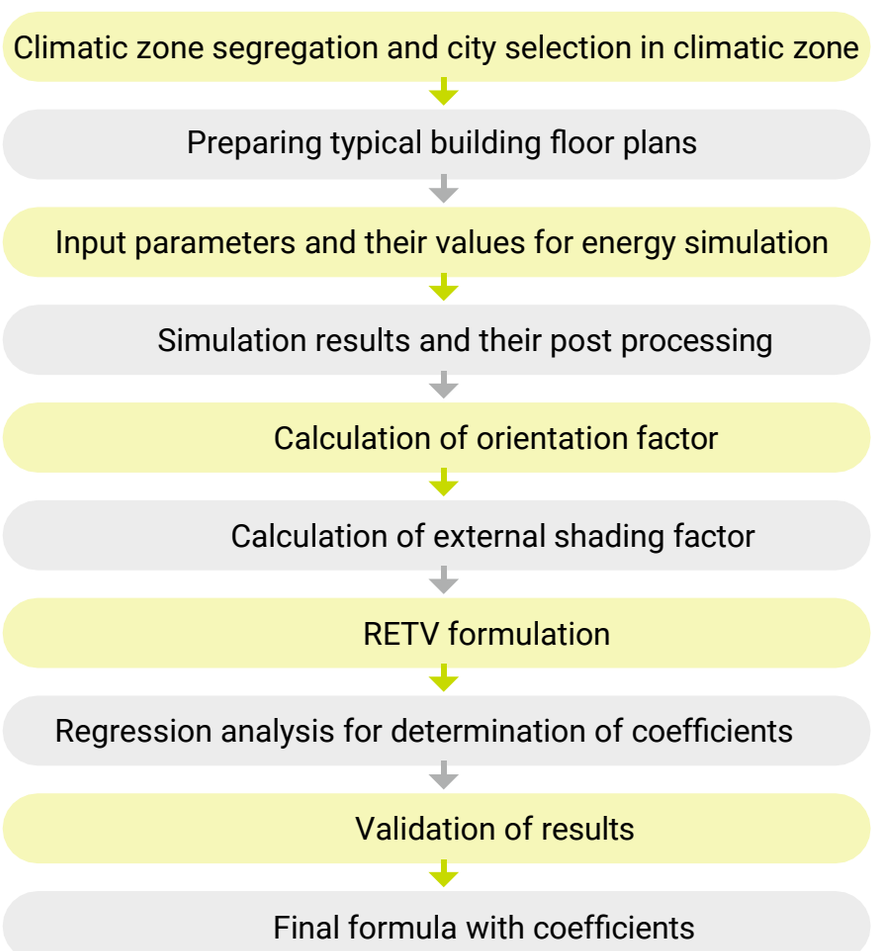


Figure 4. Methodology for RETV Calculation

The RETV calculation of the building envelope **for Composite, Hot & Dry, Warm- Humid, Temperate** shall be carried out using Equation –

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

Term I

Term II

Term III

Where,

$A_{envelope}$: Total area of the building envelope (excluding roof and floor), i.e. walls + windows (m²).

$A_{opaquei}$: Area of opaque elements of the envelope (e.g., wall portion without windows) on façade i (m²).

$U_{opaquei}$: Thermal transmittance (U-value) of the opaque element (wall) for façade i (W/m²·K).

Anon-opaquei: Area of non-opaque elements (windows/glazing) on façade i (m²).

$U_{non-opaquei}$: Thermal transmittance (U-value) of non-opaque element (window/glass) for façade i (W/m²·K).

$SHGC_{eqi}$: Equivalent Solar Heat Gain Coefficient of glazing on façade i (accounts for shading, overhangs, fins, etc.).

ω_i: Orientation weighting factor for façade i, derived from solar radiation and temperature difference specific to orientation (N, S, E, W, NE, NW, etc.) and climate zone.

a, b, c → Empirical coefficients (from ENS tables) used to normalize heat gains for:

a → Opaque conduction
b → Window conduction
c → Solar heat gain through windows
n → Number of envelope segments/facades considered.

RETV equation has three terms – Term I, Term II and Term III.

- To calculate Term I, U value of the wall construction material is calculated (thermal conductivity is required), envelope lengths and height of the tower are measured from the architectural drawing.
- For Term II, window areas are referred from the door window schedule drawing and glass specifications is referred from the material test certificate.
- For Term III, H and V values are measured for shading devices overhang and side fin from the architectural drawings (Figure 5).

Coefficients (a, b, and c) for RETV formula

Climatic Zones	a	b	c
Composite	6.06	1.85	68.99
Hot and Dry	6.06	1.85	68.99
Warm-Humid	5.15	1.31	65.21
Temperate	3.38	0.37	63.69

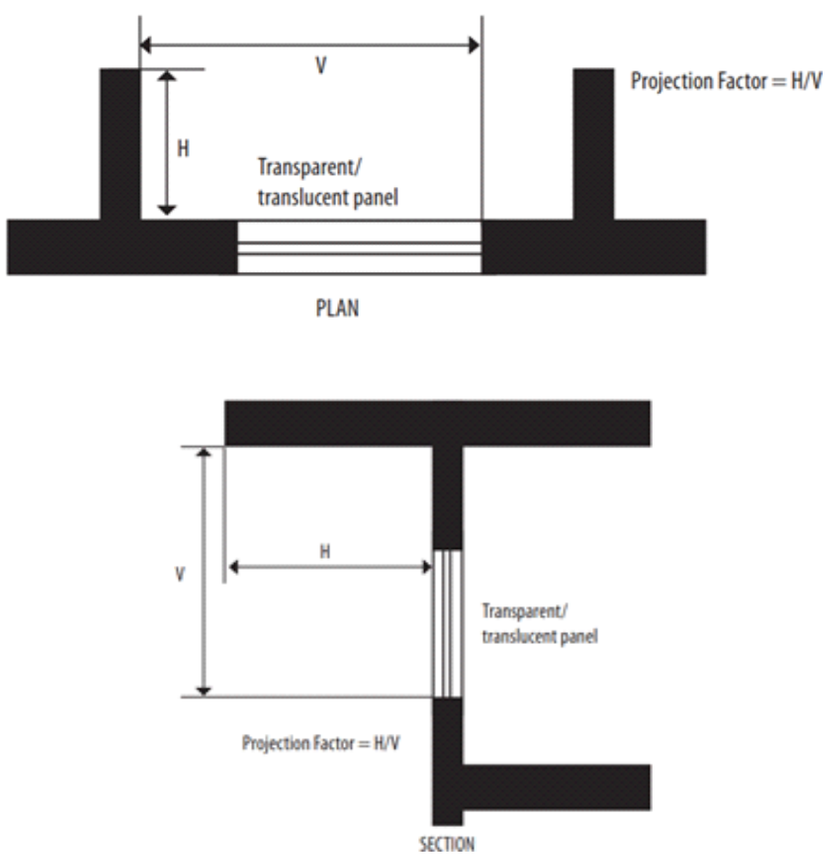


Figure 5. Projection Factor for Overhangs

Input Parameters

For Opaque Elements

Sr No.	Construction Material	Thickness	U Value ($W/m^2.K$)
1	**AAC Block**	15mm Plaster (External); 170mm AAC Block, 10mm Plaster (Internal)	**0.78**
2	**RCC Shear Wall**	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal)	**3.2**
3	**Red Brick wall**	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal)	**2.82**

For Non-Opaque Elements

Sr No.	Glass Details	WWR	Proposed SHGC	Effective SHGC	U Value ($W/m^2.K$)
1	6mm Single clear glass, U-glass=5.7 $W/m^2.K$, SHGC=0.83	15%	0.85	0.68	**5.7**

As per Eco Niwas Samhita, to meet the RETV compliance requirement, the project should achieve an RETV ≤ 15 W/m^2.

SAMPLE CALCULATION

AAC Blocks For Composite Climate

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

Term I

Term II

Term III

Climatic Zones	a	b	c
Composite	6.06	1.85	68.99
Hot and Dry	6.06	1.85	68.99
Warm-Humid	5.15	1.31	65.21
Temperate	3.38	0.37	63.69

A envelope = Opaque Area + Non-Opaque Area

A envelope = 3793.37 + 414

A envelope = 4270.7 m^2

RETV For Composite Climate (Ranchi)

= 1/A envelope x {a x (TERM I)} + {b x (TERM II)} + {c x (TERM III)}
= 1/4207.7 x {6.06 x (2625)} + {1.85 x (1962.83)} + {68.99 x (234.16)}
= 8.48

Opaque Area - TERM I					
Orientation	**Component**	**Area (1)**	**U Value(2)**	**Orientation Factor(3)**	**(1)x(2)x(3)**
NORTH	OPAQUE (AAC Block)	1513	0.78	0.65	777.71
SOUTH	OPAQUE (PVC Door Panel)	3.7	5.23	0.96	18.69
SOUTH	OPAQUE (AAC Block)	1513	0.78	0.96	1140.01
EAST	OPAQUE (AAC Block)	382	0.78	1.15	344.14
WEST	OPAQUE (AAC Block)	382	0.78	1.15	344.44
TOTAL					**2625**

Non-Opaque Area - TERM II					
Orientation	**Component**	**Area (1)**	**U Value(2)**	**Orientation Factor(3)**	**(1)x(2)x(3)**
NORTH	NON - OPAQUE (GLASS)	181	5.7	0.65	679.89
SOUTH	NON - OPAQUE (GLASS)	233	5.7	0.96	1282.94
TOTAL					**1962.83**

SHGC EQUIVALENT - TERM III					
Orientation	**Component**	**Area (1)**	**U Value(2)**	**Orientation Factor(3)**	**(1)x(2)x(3)**
NORTH	NON - OPAQUE (GLASS)	181	0.68	0.65	81.10
SOUTH	NON - OPAQUE (GLASS)	233	0.68	0.96	153.05
TOTAL					**234.16**

RESULT AND ANALYSIS

1. AAC Blocks

Sr No.	Climatic Zone	Location	Construction Details		WWR	Effective SHGC	RETV
			Wall	Glass			
1	**Composite**	New Delhi, Hyderabad, Ranchi, Jaipur	12mm Plaster (External); 200mm AAC Block Uwall=0.78 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC=0.83	15%	0.68	**8.48**
2	**Hot and Dry**	Surat, Ahmedabad, Jodhpur, Aurangabad	12mm Plaster (External); 200mm AAC Block Uwall=0.78 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC=0.83	15%	0.68	**8.48**
3	**Warm-Humid**	Mumbai, Kolkata, Chennai, Pune	12mm Plaster (External); 200mm AAC Block Uwall=0.78 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC=0.83	15%	0.68	**7.45**
4	**Temperate**	Bengaluru	12mm Plaster (External); 200mm AAC Block Uwall=0.78 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC=0.83	15%	0.68	**5.82**

2. RCC Shear Wall

Sr No.	Climatic Zone	Location	Construction Details		WWR	Effective SHGC	RETV
			Wall	Glass			
1	**Composite**	New Delhi, Hyderabad, Ranchi, Jaipur	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal) U-wall=3.20 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC =0.83	15%	0.68	**20.13**
2	**Hot and Dry**	Surat, Ahmedabad, Jodhpur, Aurangabad	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal) U-wall=3.20 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC =0.83	15%	0.68	**20.13**
3	**Warm-Humid**	Mumbai, Kolkata, Chennai, Pune	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal) U-wall=3.20 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC =0.83	15%	0.68	**17.35**
4	**Temperate**	Bengaluru	15mm Plaster (External); 170mm RCC Shear Wall, 10mm Plaster (Internal) U-wall=3.20 W/m^2. K	6mm Single clear glass, U-glass=5.7 W/m^2. K, SHGC =0.83	15%	0.68	**12.32**

3. Red Bricks

Sr No.	Climatic Zone	Location	Construction Details		WWR	Effective SHGC	RETV
			Wall	Glass			
1	**Composite**	New Delhi, Hyderabad, Ranchi, Jaipur	15mm Plaster (External); 200mm Red Brick wall, 10mm Plaster (Internal) U-wall =2.82 W/m².K	6mm Single clear glass, U-glass=5.7 W/m². K, SHGC=0.83	15%	0.68	**18.30**
2	**Hot and Dry**	Surat, Ahmedabad, Jodhpur, Aurangabad	15mm Plaster (External); 200mm Red Brick wall, 10mm Plaster (Internal) U-wall =2.82 W/m².K	6mm Single clear glass, U-glass=5.7 W/m². K, SHGC=0.83	15%	0.68	**18.30**
3	**Warm-Humid**	Mumbai, Kolkata, Chennai, Pune	15mm Plaster (External); 200mm Red Brick wall, 10mm Plaster (Internal) U-wall =2.82 W/m².K	6mm Single clear glass, U-glass=5.7 W/m². K, SHGC=0.83	15%	0.68	**15.79**
4	**Temperate**	Bengaluru	15mm Plaster (External); 200mm Red Brick wall, 10mm Plaster (Internal) U-wall =2.82 W/m².K	6mm Single clear glass, U-glass=5.7 W/m². K, SHGC=0.83	15%	0.68	**11.30**

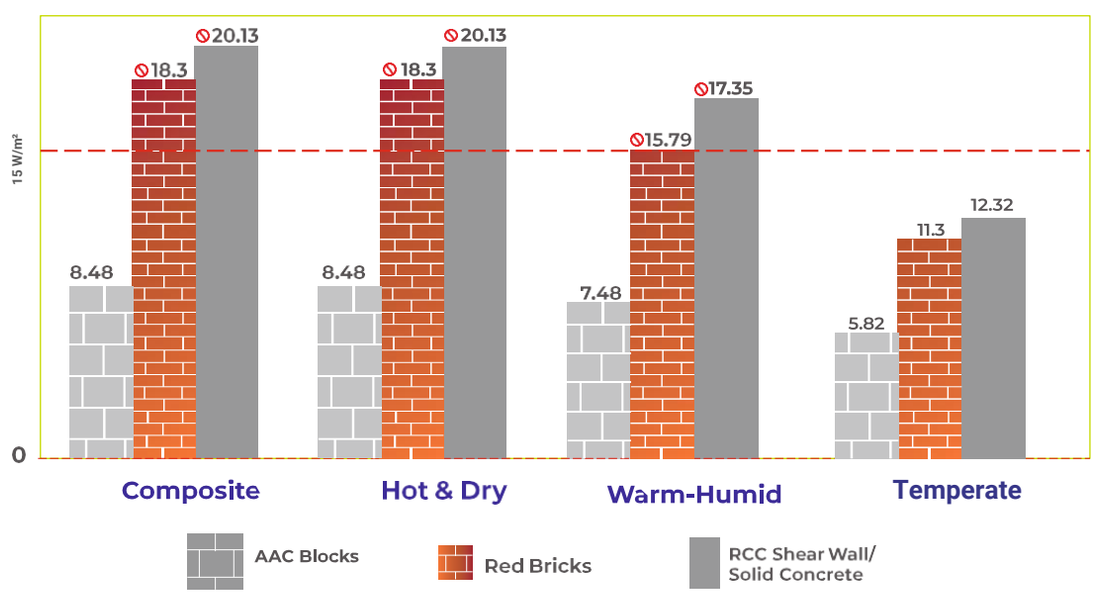
CONCLUSION

This comparative study demonstrates the significance of walling material selection in ensuring compliance with the **Eco Niwas Samhita (ENS) 2018** RETV benchmarks across India's diverse climatic zones. By evaluating AAC Blocks, RCC Shear Walls, and Red Clay Bricks, it is evident that **AAC Blocks consistently meet the RETV threshold of ≤15 W/m² in all four climatic zones**, making them the most versatile and energy-efficient walling material.

Conversely, **RCC Shear Walls and Red Clay Bricks only achieve compliance in temperate climates** and fail to meet the required RETV standards in composite, hot–dry, and warm–humid climates. These results highlight the risks of increased cooling loads and reduced thermal comfort when conventional walling materials are used in most regions of India.

The analysis underscores the importance of aligning material choices with national energy codes, not only to improve thermal comfort but also to reduce long-term energy consumption in residential buildings. Future work may further explore hybrid walling systems, façade treatments, and advanced construction technologies that can complement AAC Blocks to achieve enhanced performance across different building typologies.

RETV Comparison



Key Takeaways

- **AAC Blocks** emerge as the most suitable walling material, ensuring RETV compliance in **all four climatic** zones and offering significant energy efficiency benefits.
- **RCC Shear Walls** show compliance **only in temperate climates,** limiting their applicability in broader residential construction.
- **Red Clay Bricks,** though widely used nationwide, are RETV-compliant **only in temperate climates,** raising concerns over their suitability for modern energy-conscious housing.

ABOUT MAGICRETE

Magicrete Building Solutions Pvt. Ltd. is India's foremost leader in **Autoclaved Aerated Concrete (AAC) Blocks** and a major provider of AAC Wall Panels, Construction Chemicals, and Precast Solutions, revolutionizing the country's construction industry with sustainable and high-performance building technologies.

Founded in 2008 by a visionary team who are alumni of IIT Kharagpur, IIT Delhi, and IIM Lucknow, Magicrete's core vision is to help people to build their homes better, faster, and more affordable through innovative technology. Over the past decade, the company has supported the construction of over **one million homes**, contributing to projects valued at approximately **₹1.5 trillion**.

Our pioneering work has earned us widespread recognition, with honors such as **"Best Realty Brand"** by ET Edge, **"India's Top Innovative MSMEs"** by ET Rise, and **"Most Promising Brand"** by the Global Real Estate Congress, among many others.

A landmark achievement came through our success in the **Global Housing Technology Challenge**, organized by the Ministry of Housing & Urban Affairs. Tasked with delivering 1,000 houses in Ranchi within a year, Magicrete accomplished the goal seamlessly using advanced **3D Modular Technology**, underscoring our reputation for speed, innovation, and reliability.

Building on these milestones, Magicrete is set to play a central role in India's **"Housing for All"** initiative. Our product portfolio is integral to a wide range of affordable housing projects across the country, creating opportunities for both urban and rural communities. With unwavering dedication to quality, sustainability, and innovation, Magicrete continues to shape the future of construction—bringing strength, efficiency, and accessibility to homeowners and industry stakeholders alike.

Reference:
Eco-Niwas Samhita 2018

magicrete®
magic behind happy homes

Magicrete Building Solutions Pvt. Ltd.
101 Ritz Square, Near Narmad Library, Ghod Dod Road, Surat-395007 (Gujarat)
80 70 40 80 10
info@magicrete.in
magicrete.in