

# Training Program on Innovative Construction Technologies & Thermal Comfort in Affordable Housing



**RACHNA for Officers on 31<sup>st</sup> May 2022, Tuesday**

**Venue:** Lemon Tree Premier, Bhubaneswar

**Time:** 10:00 AM to 5:30 PM

‘RACHNA for Officers’ training program delivered in-depth knowledge on thermal comfort, its nuances, and its relationship with building physics. Moreover, it discussed design strategies, construction techniques, policy documents, building codes, international practices, and other aspects relevant to thermal comfort in affordable housing through a suite of case studies. Additionally, it familiarized participants with the evaluation process of thermal comfort, the statistics, and indicators involved as well as affordable cooling technologies and their applicability in various climates.

## Session proceedings

Thermal Comfort Training Module		
10h00 – 10h10	Welcome address and Introduction	Dr. Rajan Rawal
10h10 – 10h15	Introduction to Climate Smart Buildings Programme (IGEN – CSB) and overview of workshop	GIZ

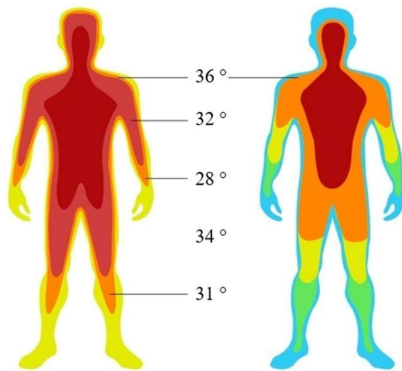
10h15 – 11h00

## Session 2 (Technical): Importance of Thermal Comfort

Dr. Rajan Rawal

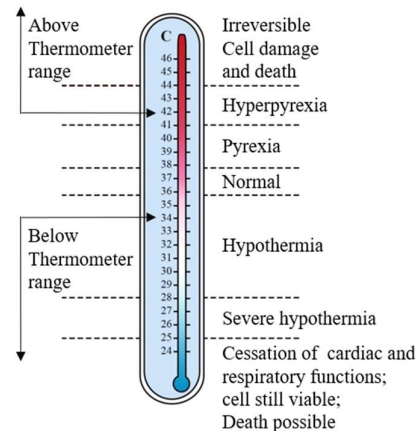
*This session established the importance of thermal comfort.*

### Importance of thermal comfort : Conditioning and Comfort



30 °C – Ambient temperature – 20 °C

Human Body Condition in two set of environment



Human Body Condition beyond comfort bands

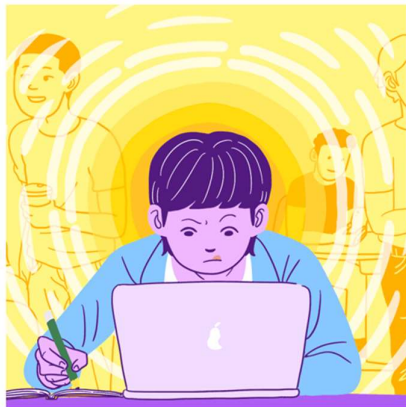
Session Title | Speaker name

Thursday, 17 March 2022 | Climate Smart Buildings: Development of Training Modules on Thermal Comfort in Affordable Housing

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*It provided an insight into the connections between comfort, physiology, health, and productivity.*

### Importance of thermal comfort : Conditioning and Comfort



- In ability to shed excess heat leads to rise in core body temperature.
- Increase heart rate
- Loss of concentration
- Irritation
- Sickness and Vomiting
- Unconsciousness
- Death

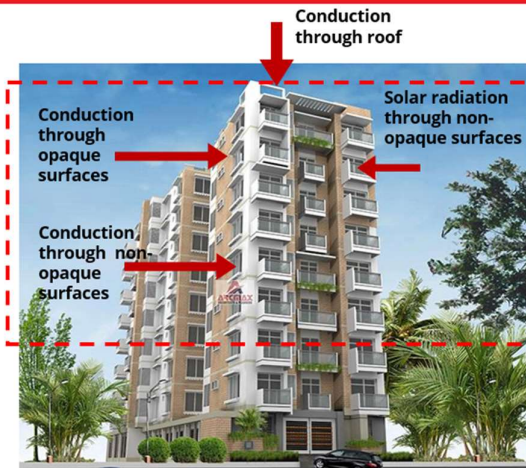
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*It briefly exposed the audience to the connection between buildings and comfort.*

## ECO NIWAS Samhita: ECBC Residential



To limit the heat gain/loss from the building envelope, the code specifies:

**Maximum value of thermal transmittance of roof ( $U_{\text{roof}} = 1.2 \text{ W/m}^2\cdot\text{K}$ ) for all climate zones**

**Maximum value of Residential Envelope Transmittance Value (RETV) for building envelope (except roof)**

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*It provided overarching guidance about the ways and means to achieve comfort in buildings.*

## Importance of thermal comfort : Ways to achieve it



- Electrical – Mechanical Systems
- Change of Air
- Air Velocity
- Cooling
- Heating

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*With the help of examples, the factors affecting thermal comfort were explained.*

## Factors Affecting Thermal Comfort: Others



Short term  
physiological  
adjustments



Long term physiological  
adjustments



- **Acclimatization**
- Short-term physiological adjustments
- Long-term endocrine adjustments



Age



Gender



Health and Wellbeing

- **Body shape and fat**
- **Age and gender**
- **Status of health**

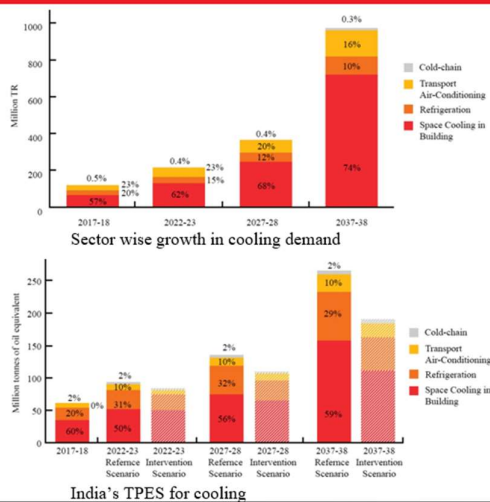
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The session ended with establishing a relation between comfort and associated energy consumption through cooling needs.

## Impact of need of Thermal Comfort: India Cooling Action Plan



### India's cooling demand

- 8 times by 2037-38
- 11 times for Building Sector compared to the baseline 2017-18
- India's Total Primary Energy Supply (TPES) for Cooling 4.5 times in 2037-38
- 30% reduction possible due to intervention – from better design and technology

Source: India Cooling Action Plan

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11h00 – 11h10

Questions and Answers

11h10 – 11h20

Health Break

11h20 – 12h05

Session 3 (Technical): Affordable Housing Passive  
Design Strategies

Dr. Rajan Rawal

*This session started with the introduction of passive design and its importance.*

## What is Passive Design?



- No universally accepted definition
- Use of building envelop components to ensure thermal comfort
  - Material Use
  - Spatial Configuration

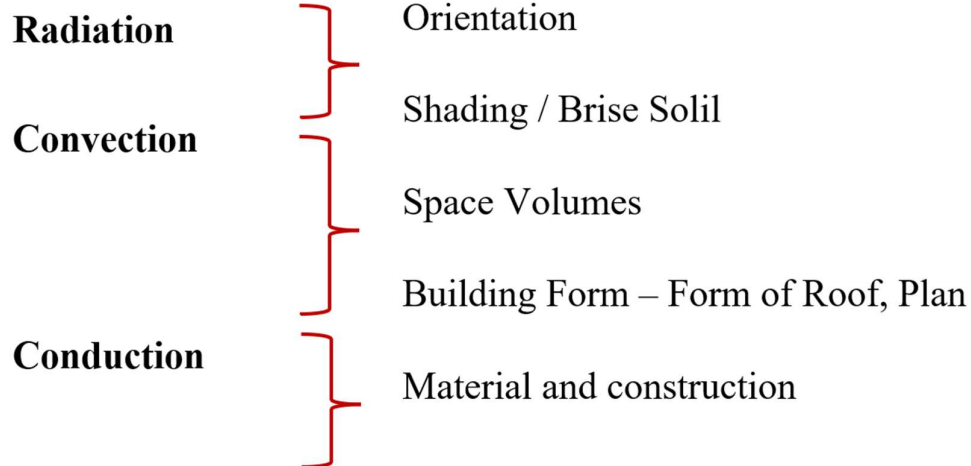
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*It provided a quick overview of various strategies that are important to be incorporated in affordable housing.*

## Passive Design Parameters : Spatial Configuration & Construction



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The session provided insights into the site level design decisions as well as building-level design decisions.

## Other Passive Design Strategies: Spatial Configuration



Optimizing Radiation



Wind Direction and Speed

Rectangular Plan  
Less 'tight' buildings

Orientation: Positive, Negative and Neutral

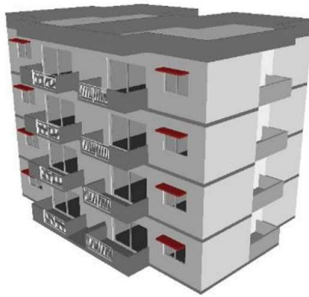
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It further provided a comparative understanding of appropriate orientation & use of building mass to reduce radiative heat gains in warm climates

## Passive Design : Residential Envelop Transmittance Value (RETV) Use of Material



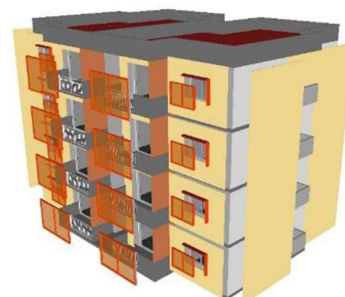
RETV 21.0 W/m²

Business As Usual Building Envelop



RETV 18.0 W/m²

Better Insulation on wall and roof (U value)  
Higher Solar Reflectance On the roof (SRI)



RETV 15.0 W/m²

Better Windows (U Value, SHGC, VLT)

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*It will guide fenestration design, location, and shading design appropriate for affordable housing. The use of appropriate ventilation for comfort and well-being was also covered in this session.*

## Other Passive Design Strategies: Spatial Configuration



- E-W Longer Axis
- E-W Vertical ,
- S Horizontal
- Latitude
- *Climate Zone?*

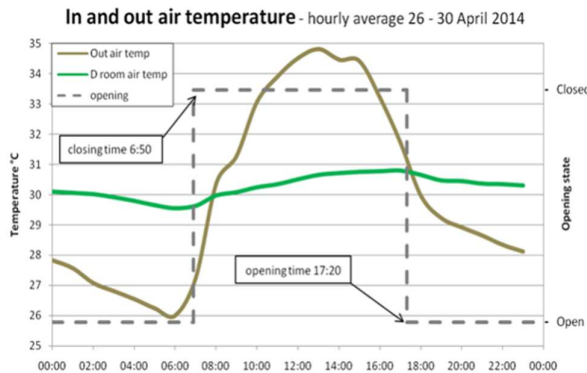
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*The session also provided selected case studies that have adopted best practice approaches at the site and at the building level to implement passive design strategies.*

## Blessings House: Auroville



- Balancing Thermal Mass and Insulation
- NV operation with controlled Ventilation
- Warm Humid Climate

**Day shutting and nighttime comfort strategy show good results in preventing excessive temperature rise in the building**

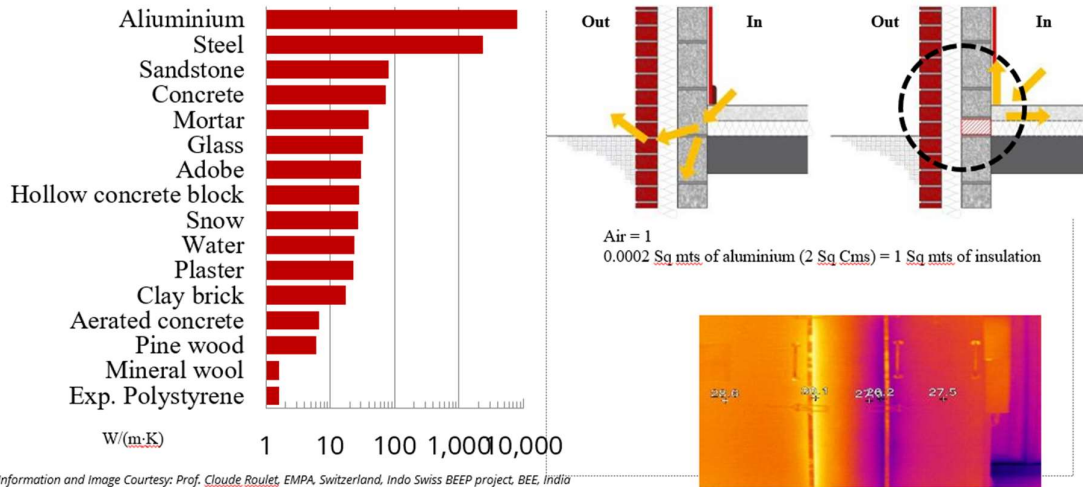
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12h05 – 12h15	Questions and Answers	
12h15 – 13h15	Session 4 (Technical): Building Materials and Methods of Construction for Affordable Housing	Dr. Rajan Rawal
This session started with the overview of affordable walling, roofing and fenestration materials and technologies.		

## Walling Materials and Methods : Conductivity & Thermal Bridge



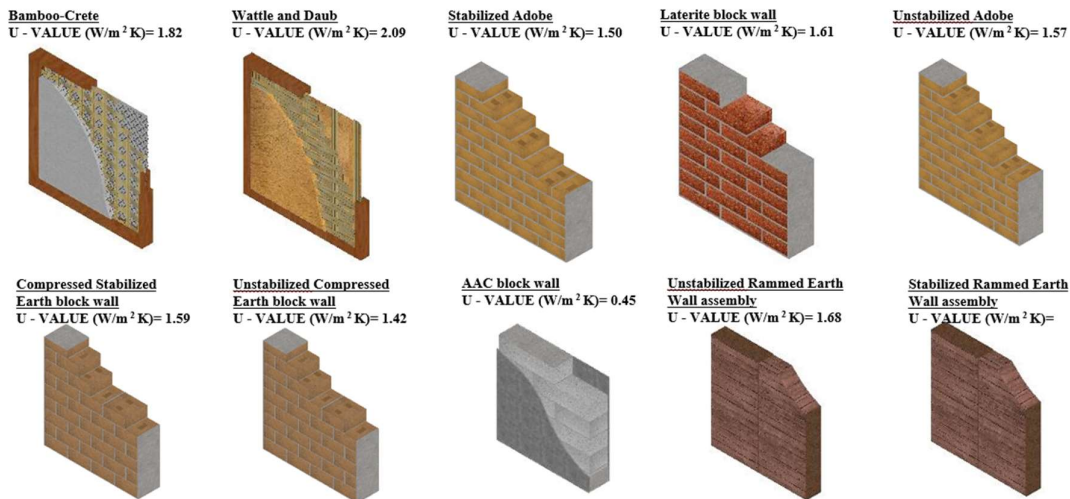
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It further detailed the appropriateness of materials and methods of the construction for housing and its applicability in various housing typologies.

## Nonhomogeneous Walling Technologies, Traditional



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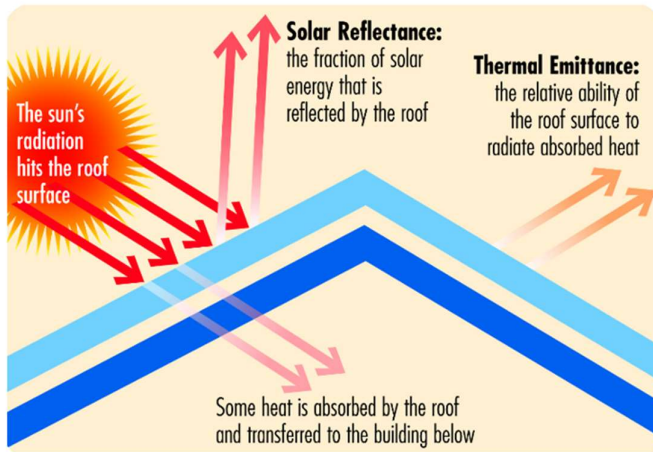
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The session further enhanced the understanding of the audience to adopt materials and methods according to the climate context.



## Roofing Coating Material and Solar Reflectance Index



- Reflectance
- Thermal Emittance.
- Emissivity
- Solar Reflectance Index (SRI)

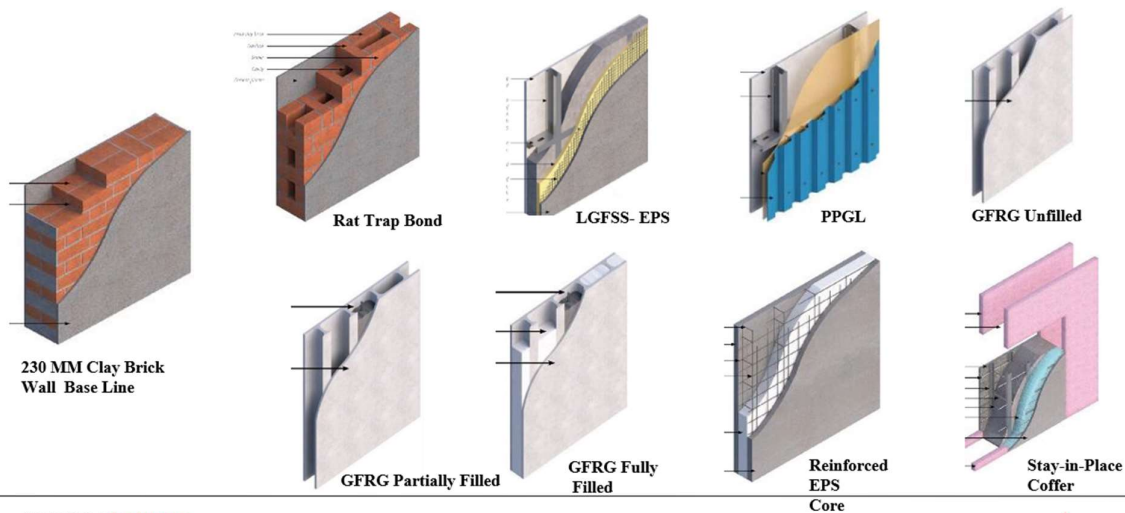
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The focus was on alternative construction technologies, low embodied carbon materials, availability of material locally and economics of it.

## Nonhomogeneous Walling Technologies, Industrial



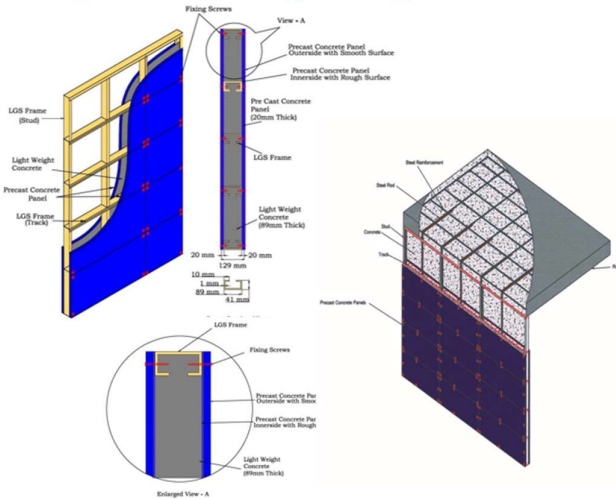
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The session also provided selected case studies of construction technologies that have been adopted in LHPs.

## Light House Project: Agartala



- Light Gauge Steel Framed Structure with Infill Concrete Panels (LGSFS-ICP)
- Ground and 06 Floors
- Weight of the LGSFS-ICP building is about 20-30% lighter
- The LSG frames manufactured using numerically controlled roll forming machine using CAD design

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## Light House Project: Lucknow



- PVC Stay in Place Formwork System
- S and 13 Floors
- Rigid poly-vinyl chloride (PVC) based form work system serve as a permanent stay-in-place durable finished form-work for concrete walls
- The PVC extrusions consist of the substrate (inner) and Modifier (outer). The two layers are co-extruded during the manufacturing process to create a solid profile.

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13h15 – 13h30

Questions and Answers

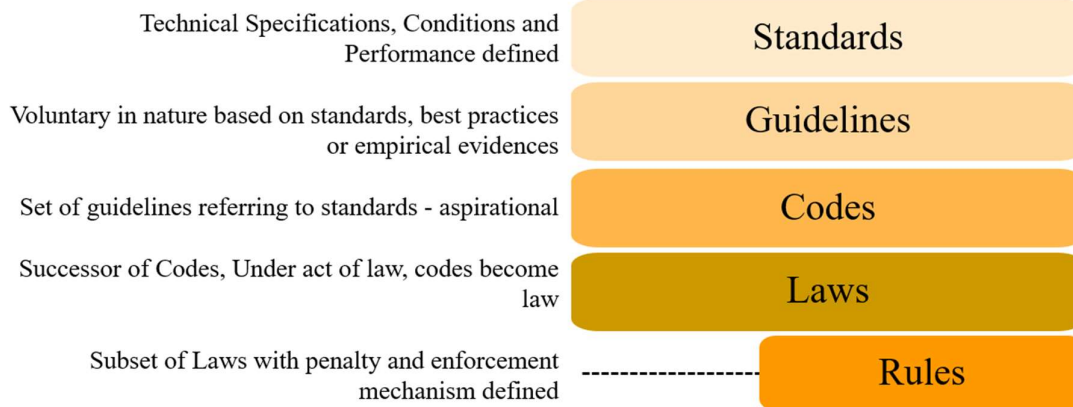
13h30 – 14h30

Lunch Break

14h30 – 15h15	<b>Session 5 (Technical): Building Codes, Affordable Housing and Thermal Comfort</b>	<b>Dr. Rajan Rawal</b>
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*This session provided an understanding of the provision of various thermal comfort-related clauses in the National Building Code, Eco Niwas Samhita, various guidelines provided by the government.*

## Standards, Guidelines, Codes, Laws, Rules.

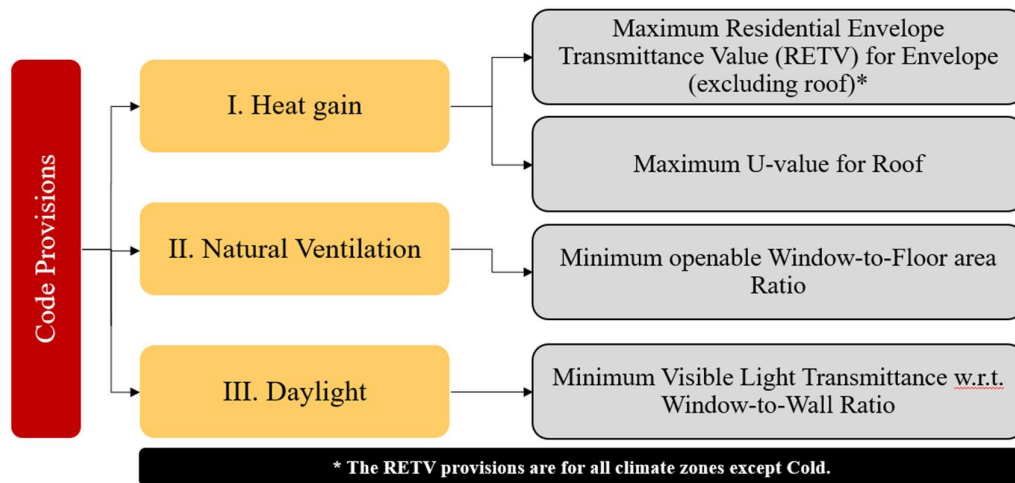


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## Overview of Code Provisions



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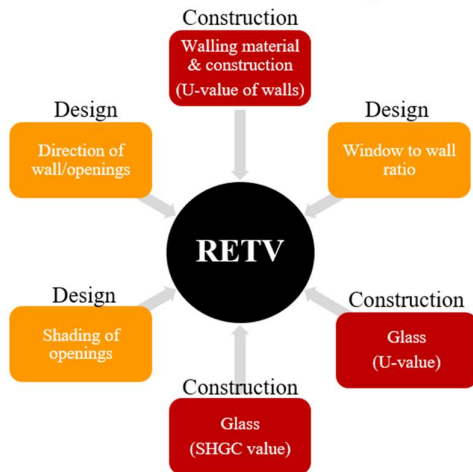
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*It also provided insights into the implementation of policy. The audience was able to comprehend the process of implementing the code at the local level. It discussed the programming of code implementation, the economics of it as well as the benefits of the codes.*

Further, this session outlined the implementation of codes through examples.

## RETV: Influencing Factors, Design and Construction



The net heat gain rate (over the cooling period)

through building envelope (excluding roof)

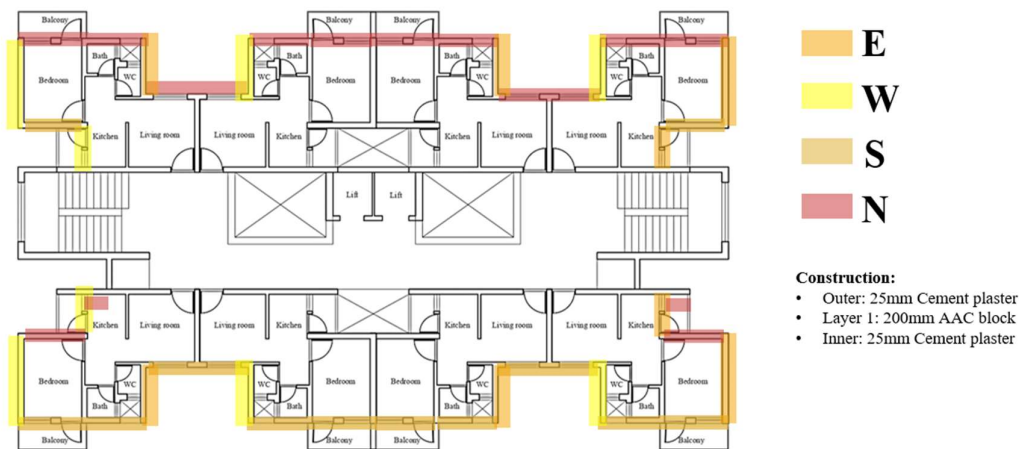
divided by the area of building envelope (excluding roof), measured in  $W/m^2$ .

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## Wall Construction details



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15h15 – 15h30	Questions and Answers
15h30 – 15h45	Health Break









15h45 – 16h45

## Session 6 (Technical): Application of Thermal Comfort in Affordable Housing- A Suite of Case Studies

Dr. Rajan Rawal

This session brought salient features of the projects that have demonstrated approaches to achieve thermal comfort in affordable housing. This session included the projects that were conceived using integrated design practices. The case studies in this session highlighted more than one aspect of the project that meets the objective of affordability and comfort. The on-site performance of the housing was also included to help the participants understand the methods of field performances.

### Case study: Shree Ram Nagar Co-operative Housing society

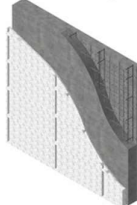

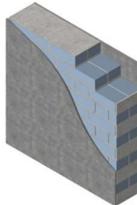
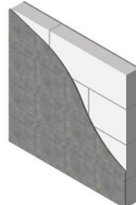

		Existing layout	Case 2: Re – oriented (Without cost)	Case 3: Re – oriented + Increased FSI (With Cost)	Calculations
 Walling Materials	 Monolithic RCC	Case 1 Case 1A 2	Case 2 Case 2A 2	Case 3 Case 3A 2	Without Shading With Shading
	 Burnt Brick	Case 1B 1 Case 1B 2	Case 2B 1 Case 2B 2	Case 3B 1 Case 3B 2	Without Shading With Shading
	 Fly Ash Brick	Case 1C 1 Case 1C 2	Case 2C 1 Case 2C 2	Case 3C 1 Case 3C 2	Without Shading With Shading
	 AAC Block	Case 1D 1 Case 1D 2	Case 2D 1 Case 2D 2	Case 3D 1 Case 3D 2	Without Shading With Shading
	 Solid concrete block	Case 1E 1 Case 1E 2	Case 2E 1 Case 2E 2	Case 3E 1 Case 3E 2	Without Shading With Shading
	Total Cases: 30				
	1. RETV 2. EPI 3. Comfort hours				

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### Case study : Existing Layout without Shading

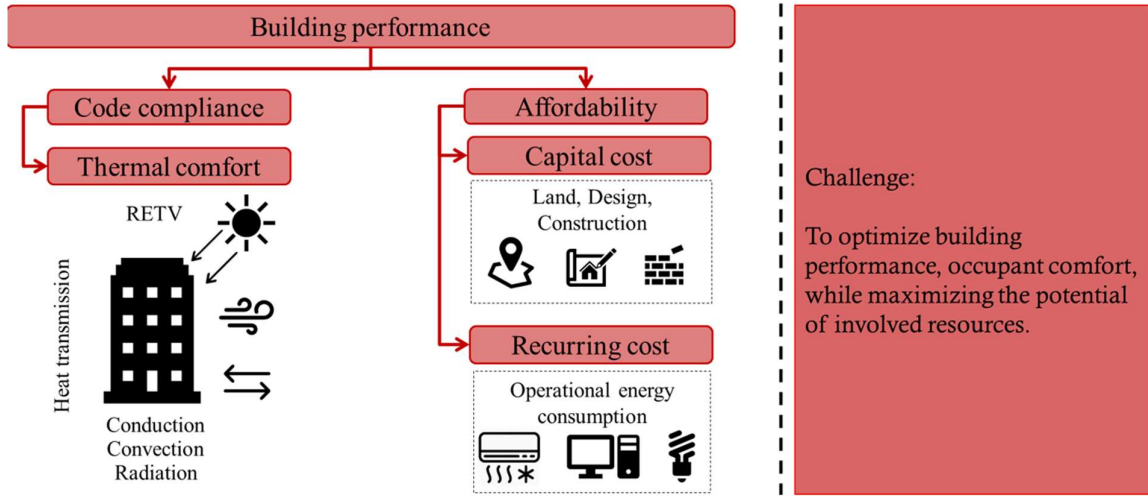
	EXISTING RCC (MASCON)	BURNT CLAY BRICK	FLY ASH BRICK	AAC BLOCKS	SOLID CONCRETE BLOCK
					
Case	Case 1	Case 1B 1	Case 1C 1	Case 1D 1	Case 1E 1
Shading	Without				
RETV	26.00	16.62	16.34	12.35	25.48
EPI	75.92	48.53	47.71	36.06	74.40
Comfort hours	4760 - 7627	4887-8599	4716-8608	1874-8760	4618-8009
Difference in cost	₹ -	₹ -79,50,926	₹ -66,03,988	₹ -76,08,377	₹ +61,12,630

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## Case study : Code and Cost



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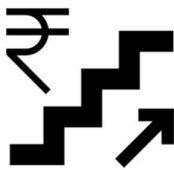
## Maximizing the potential of resources



Incentive to  
contractor



Land usage is  
optimized.  
Land value is  
achieved.



Profit increases.  
(even on a break-even  
regime, the contractor  
will benefit)



More dwelling  
units,  
accommodating  
more people.  
More comfortable  
homes.

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16h45 – 16h55	Questions and Answers	
16h55 – 17h25	Session 7: Overview of Innovative construction technologies implemented in Light House Projects (LHPs)	Abdullah Nisar Siddiqui, GIZ
17h25 – 17h30	Feedback and Concluding Remarks	Ms. Palak Patel