

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



RACHNA for Officers on 11th July 2022, Monday

Venue: Online (Zoom)

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 – 10h10	Introduction to Climate Smart Buildings Programme (IGEN – CSB)	Mr. Abdullah Nisar Siddiqui, GIZ
10h10 – 10h15	Overview of workshop	Ms Palak Patel

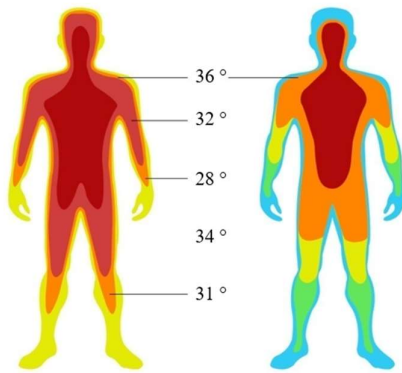
10h15 – 11h00

Session 2 (Technical): Importance of Thermal Comfort

Dr. Rajan Rawal

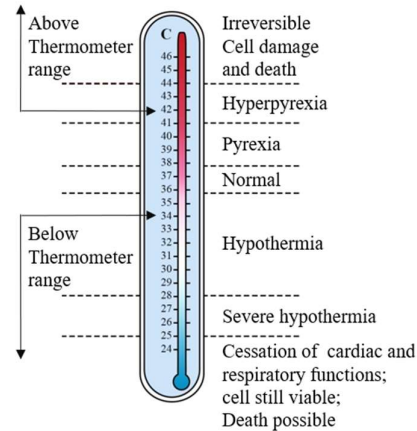
This session established the importance of thermal comfort.

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

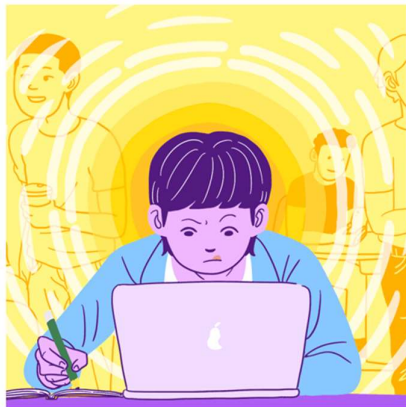
Session Title | Speaker name

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

giz 4 / 46

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

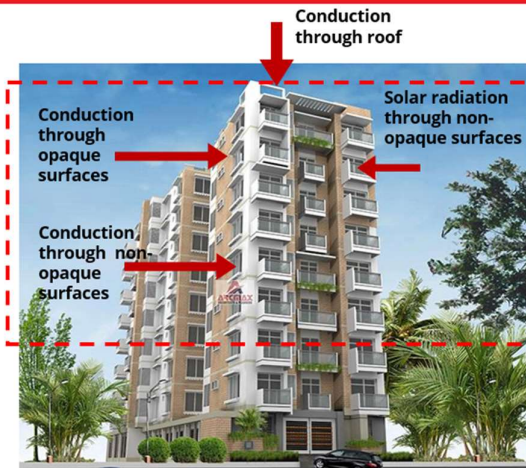
Session Title | Speaker name

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

★ giz 5 / 46

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)

Session Title | Speaker name

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

giz | 21 / 46

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

Session Title | Speaker name

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

giz | 6 / 46

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**

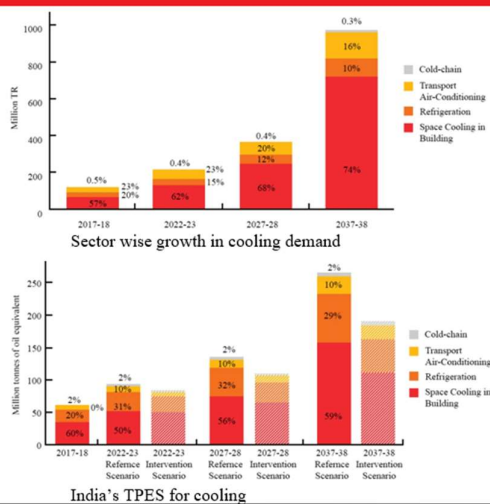
Session Title | Speaker name

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

giz 26 / 46

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

Session Title | Speaker name

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

giz 11 / 46

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

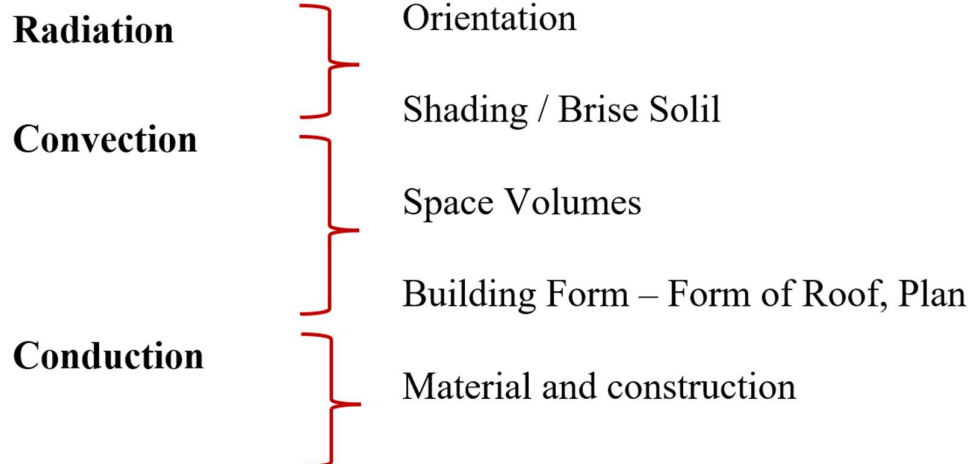
Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

3 / 47

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

Passive Design Parameters : Spatial Configuration & Construction



Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

5 / 47

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

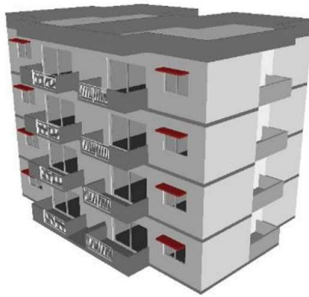
Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

12 / 47

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



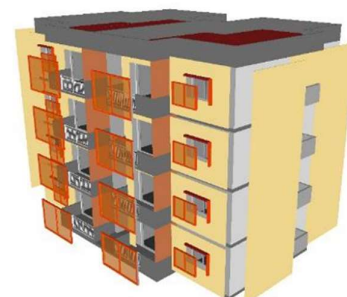
RETV 21.0 W/m²

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)

Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

9 / 47

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?*

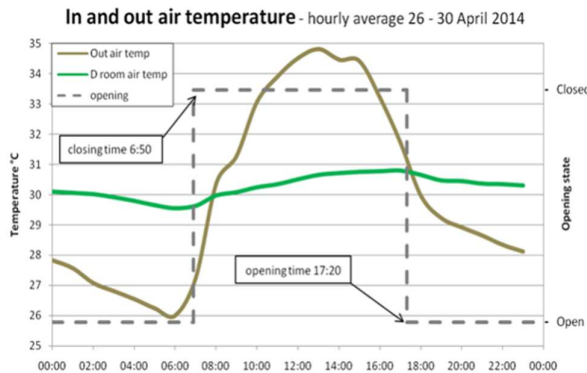
Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

13 / 47

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

Session Title | Speaker name

Friday, 18 March 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

19 / 47

12h05 – 12h10	Questions and Answers	
12h10 – 12h15	Special Address	Mr. Bipin Talati, JS, Climate Change Department, Govt. of Gujarat

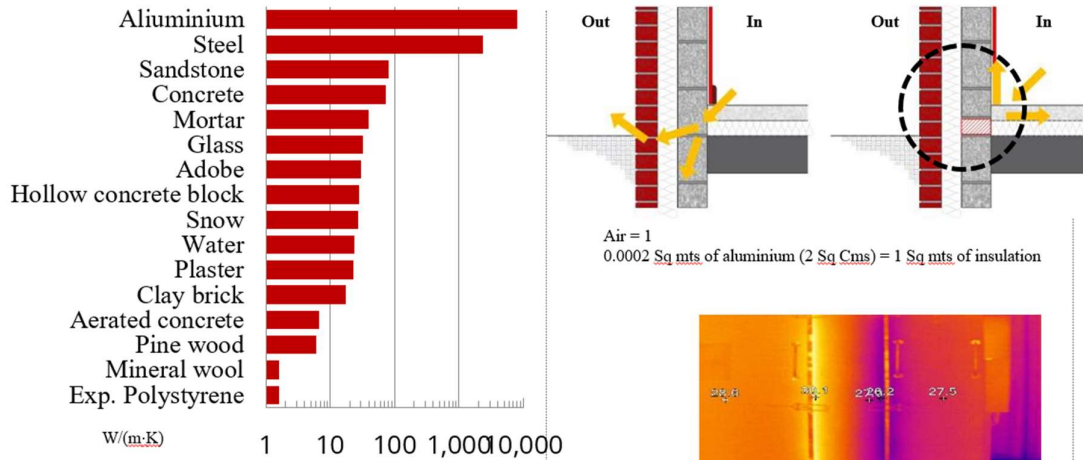
12h15 – 13h15

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



Information and Image Courtesy: Prof. Claude Roulet, EMPA, Switzerland, Indo Swiss BEEP project, BEE, India

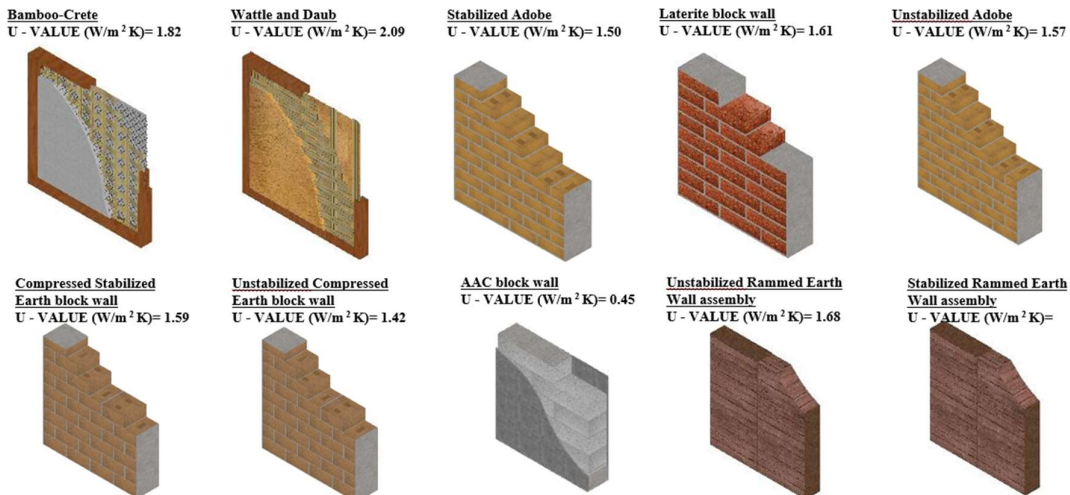
Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

8 / 42

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



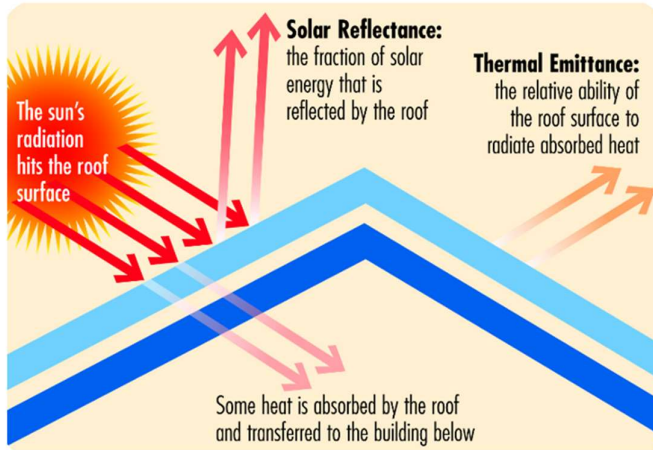
Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

16 / 42

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)

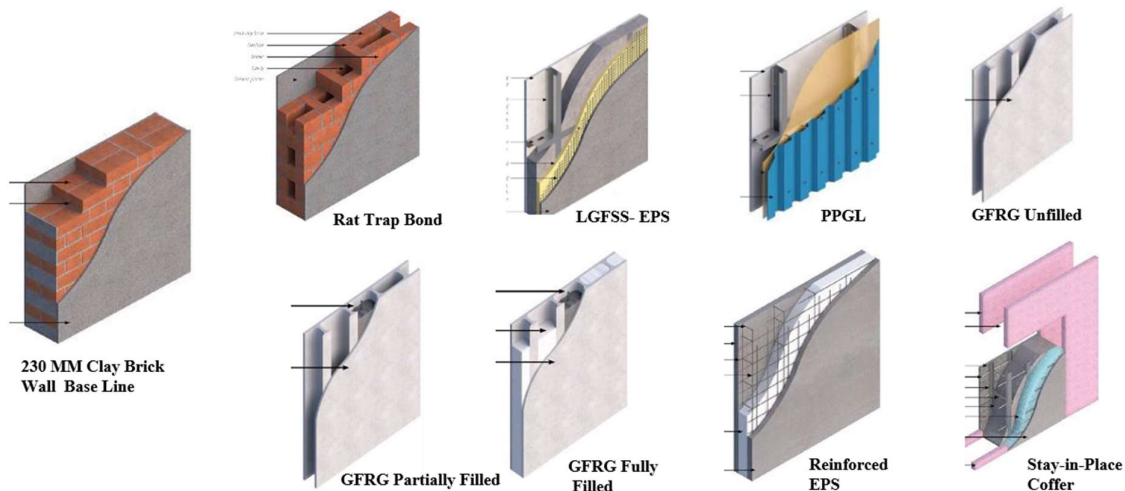
Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

28 / 42

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

Nonhomogeneous Walling Technologies, Industrial



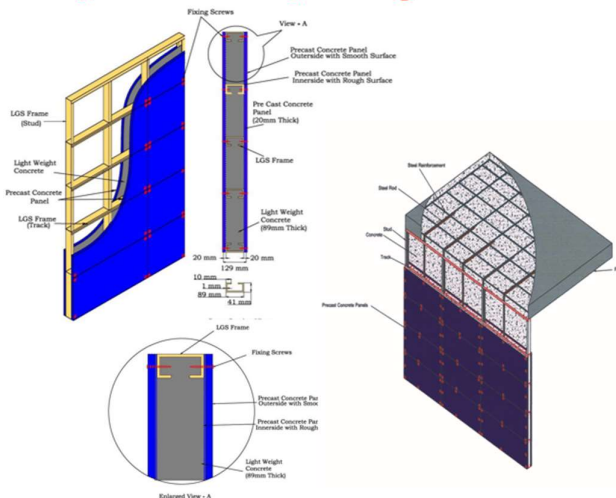
Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

14 / 42

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

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

33 / 42

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.

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

36 / 42

13h15 – 13h30	Questions and Answers
13h30 – 14h30	Lunch Break

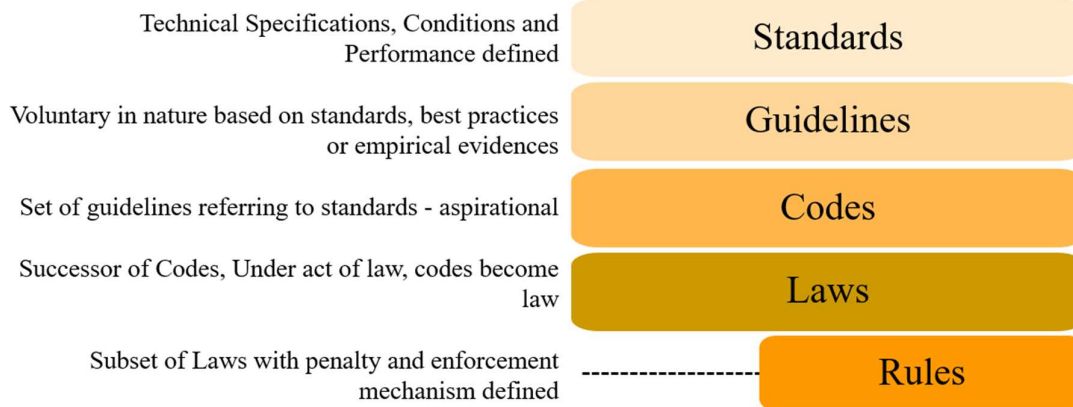
14h30 – 15h15

Session 5 (Technical): Building Codes, Affordable Housing and Thermal Comfort

Dr. Rajan Rawal

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.

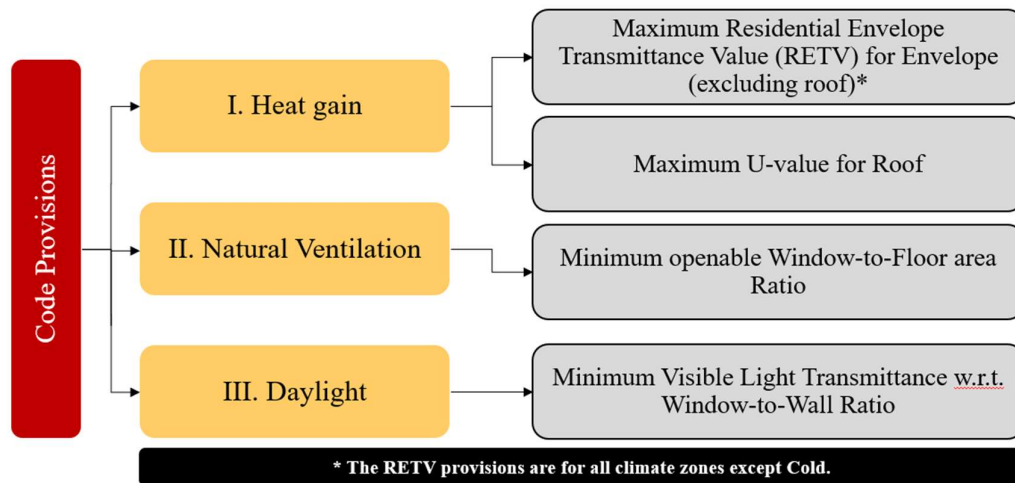


Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

6

Overview of Code Provisions



Session Title | Speaker name

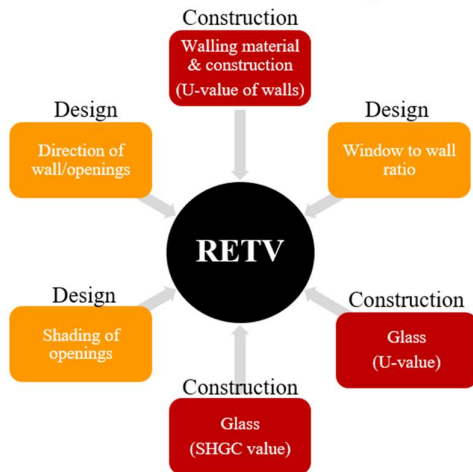
Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

15

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)

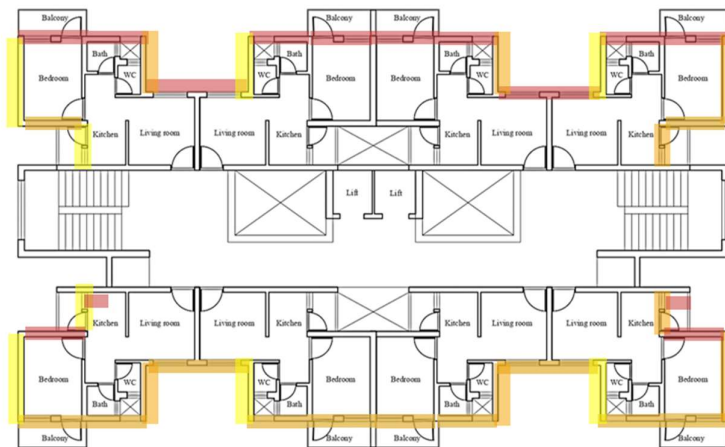
divided by the area of building envelope (excluding roof), measured in W/m^2 .

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

18

Wall Construction details



E
W
S
N

Construction:

- Outer: 25mm Cement plaster
- Layer 1: 200mm AAC block
- Inner: 25mm Cement plaster

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

33

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
					1. RETV 2. EPI 3. Comfort hours

Total Cases: 30

Total Cases: 30

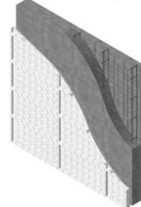
Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

6 / 50

Case study : Existing Layout without Shading

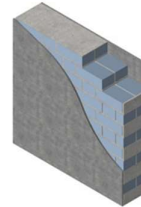
EXISTING RCC
(MASCON)



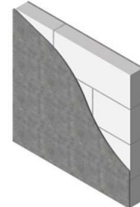
BURNT CLAY BRICK



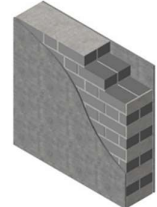
FLY ASH BRICK



AAC BLOCKS



SOLID CONCRETE
BLOCK



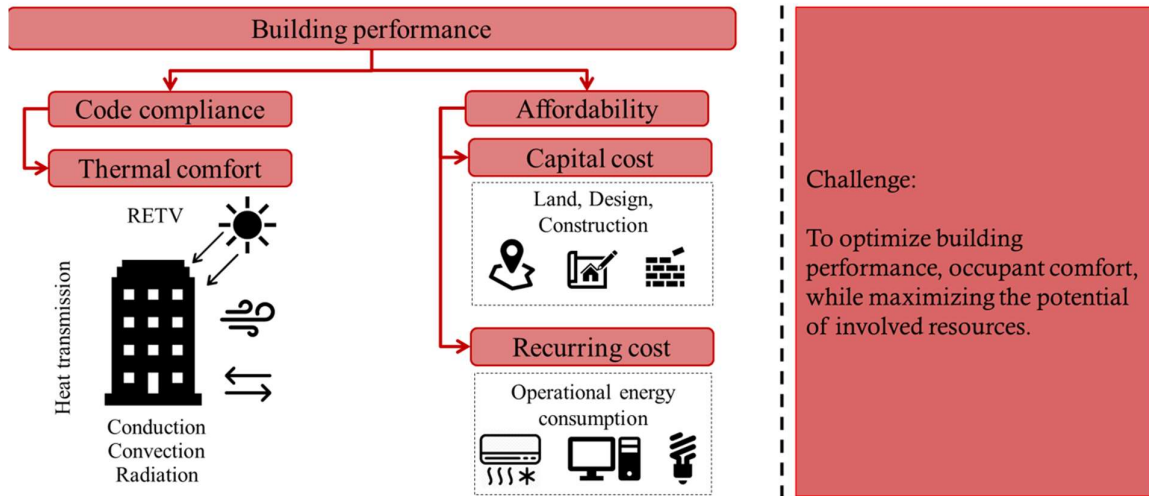
Case	Case 1	Case 1B 1	Case 1C 1	Case 1D 1	Case 1E 1
Shading			Without		
RETV	26.00	16.62	16.34	12.35	25.48
EPI	75.92	48.53	47.71	36.06	74.40
Comfort hours	4760 - 7627	4887-8599	4716-8608	1874-8760	4618-8009
Difference in cost	₹ -	₹ -79,50,926	₹ -66,03,988	₹ -76,08,377	₹ +61,12,630

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

10 / 33

Case study : Code and Cost



Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

15 / 33

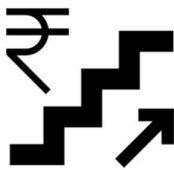
Maximizing the potential of resources



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.

Session Title | Speaker name

Tuesday, 17 May 2022 | Climate Smart Cities: Development of Training Modules on Thermal Comfort in Affordable Housing

25 / 33

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