Towards thermal comfort in affordable housing sector: Setting the agenda for new normal

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Roundtable: Mainstreaming thermal comfort in affordable housing
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Pre-pandemic roots

Policies to promote energy efficiency in buildings and appliances (ECBC, ECBC-R, energy labelling etc)

Pradhan Mantri Awas Yojana – Housing for all -- address shortfall in low income housing

Shift in policy focus towards thermal comfort for all:

• **India’s Cooling action plan (ICAP):** Cooling demand to increase 11 times in buildings between 2017-18 and 2037-38

• **ICAP target** -- reduce cooling demand by 25-30% by 2037-38, Reduce cooling energy requirement by 20-40% by 2037-38

• **Set thermal comfort standard to prevent energy guzzling and energy lock in**
Affordable housing policy – Pradhan Mantri Awas Yojana – evolving

- **AHP**
  - Affordable housing in Partnership with private or public sector
  - Assistance of Rs. 1.5 lakh per EWS house.

- **BLC**
  - Beneficiary-Led individual House Construction or Enhancement
  - Govt grant @ Rs. 1.5 Lakh per House

- **CLSS**
  - Affordable housing through Credit linked Subsidy Scheme
  - Upfront interest subsidy ranging from 3 to 6.5%

- **ISSR**
  - In-Situ Slum Redevelopment using land as a resource
  - Govt grant @ Rs. 1.00 Lakh per House
Insight from the PMAY progress....

As of 11 Nov 2019, MoHUA

- **Beneficiary led individual house construction**: 63% of incentives; (With pattas/ security of tenure beneficiaries motivated to improve their houses)
- **Affordable housing** in Partnership – 32%
- **In-situ slum redevelopment** – 2%
- **Credit linked subsidy scheme** – 3% (Most defaults in housing loan up to Rs 2 lakh - 2017-18; Banks shy away; Application process for EWS households complicated etc)
Housing for low income groups – what matters

Housing demand by income classes

- Security of tenure
- Availability of services, Facilities and infrastructure
- Affordability

**Thermal comfort**
- Habitability
- Accessibility
- Location
- Cultural adequacy

Source: Technical Group on Urban Housing

Shortage 2012

<table>
<thead>
<tr>
<th>Income Class</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>EWS</td>
<td>40%</td>
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<tr>
<td>LIG</td>
<td>56%</td>
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<tr>
<td>MIG and above</td>
<td>4%</td>
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Pandemic: The inflexion point .....
Pandemic reinforces thermal comfort concerns

Learning from Delhi:

- Overall electricity demand dropped during hard lockdown but bounced back quickly – heat trapping buildings kept residential demand at near normal level.

- Every degree rise in heat index resulted in 187 MW increase in electricity demand during lockdown – this was 6 per cent higher than 2019.

- Night time energy peaks bears out disproportionate impact of residential cooling demand – every degree change in daily mean heat index led to over 225MW change in average night time demand.

- Despite work from home and economic slow down afternoon curve flattened – more adaptive and higher thermal tolerance during the day?

- Concern over active cooling and the virus.
PMAY responds to migrant crisis

Affordable Rental Housing Complexes (ARHC):
Ease of living for urban migrants and poor announced as a sub scheme of PMAY

• Acknowledges COVID19 and reverse migration of workers; compromised living conditions in slums; how inaccessibility increases transport costs etc

• To provide “dignified living”

• To leverage existing vacant housing and to construct new rental building stock

• Important step forward to address equity concerns
Will COVID-19 slow down ICAP ambition?

- India’s residential sector is adding at least 178 million sqm of residential floor area every year
- About 1–1.2 million dwelling units are expected to get added to the formal housing stock within the next few years
- Are thermal comfort interventions getting deferred?
Electricity consumption - proxy of thermal discomfort

2019 CSE study – Midsummer Nightmare:

**Delhi:** Long-term electricity consumption pattern (2010-18):
-- Electricity consumption in summer starts to rise exponentially only after the daily heat index temperature crosses the 31-32°C mark.

-- Once the 25-32°C heat index is breached, impact of mechanical cooling (ACs) shows up noticeably.

Source: CSE analysis

Source: CSE: Midsummer Nightmare
Post pandemic: Towards thermal comfort
Material disruption:
From construction to manufacturing of buildings
Alternative construction technology

Shearwall using Tunnel formwork
Alternative construction technology

Shearwall using aluminium formwork

Pre-cast concrete
States are transitioning to alternative walling technologies.

Pre-cast concrete structures
Hyderabad, Telangana
Hyderabad

Monolithic concrete structure using tunnel formwork
Hyderabad

Monolithic concrete structure using aluminium formwork

Hyderabad, Telangana
Jaipur

Monolithic concrete structures
Karnataka

Monolithic concrete structure using aluminium formwork

Tumkur, Karnataka
Uninformed material transition may promote thermally inefficient buildings

U-value of monolithic concrete wall is 60 per cent higher than that of regular burnt clay brick wall

Cost of constructing wall panel (Rs)

This cost is going into fast-paced but heat-intensive structures

Capped construction costs push fast-paced technologies to save on time, labour costs and linked loan interest etc

Source: Compiled from several CPWD Schedule of Rates 2018-19
Reality check:
We have understood how thermal comfort of affordable housing is deeply affected by layout, orientation, walling, clustering, day lighting and ventilation ………
Eco Niwas Samhita compliance in affordable housing in Tenlangana

(Kollur, Gajwel, D Pochampally, YSR Nagar – Mostly composite climate; one warm and humid

Assessed building envelope compliance under Eco Niwas Samhita (ECBC-R) – (RETV and heat gain)

What did we find?

- Appropriate building orientation can substantially lower heat gain
- In D Pochampally: East-West facing façade had upto 17% extra heat gain compared to the same building facing North-South.

- The heat gain dropped by about 40% in the same building design when the material was changed from concrete blocks to fly ash bricks (used in Telangana govt. housing projects).

- Need to identify better performing materials to prioritise
Thermal Comfort

Thermal comfort and thermal discomfort due to design and construction technologies in different housing sites in Telangana.

What did we find?

- Combined impact of design and walling material can increase annual thermal comfort hours compared to conventional material and uninformed design by up to over 330 hours.

- Thermal massing properties of a material needs assessment along with insulation properties.

- Even the sequence of materials in walling plays a role in thermal performance.

- Need guidance on orientation, surface exposure, shading devices – This can delay/eliminate transition to mechanical space cooling.

Same design when simulated with AAC block of 150mm thickness about 152 thermally comfortable hours are gained over the base case concrete blocks (150 mm). But with 250mm AAC block thickness + with proper window shading thermally comfortable hours increase to 272 hours.
Daylighting

Analysis checked for compliance with targeted daylight factor requirements of NBC 2016.

What did we find?

- Lower floors in high rise buildings have poor daylight ingress.

- In Kollur ‘L’ block the ground floor units achieved sufficient daylight only on 7% of the area when placed in a building cluster; the top floor achieved 42% sufficiently daylit area.

- Building clustering and distance between buildings require attention in the layout plan.

- Blocks with a central courtyard typology performed better than linear blocks because of the light ingress from two sides in the dwelling units.

- This needs guidance
How can PMAY support be linked more explicitly with thermal comfort performance?

Central Government incentives

- “Infrastructure status” to affordable housing
- Central public enterprises to give priority to use of land for affordable housing
- GST reduced to 1% (from 8%)
- PMAY requires states to provide additional FAR and FSI, or TDR and relaxed density rules for slum redevelopment and low-cost housing

State government incentives

- Exemption from stamp duty, additional FAR and TDR, Relaxed density rules
- Providing free sand, steel and cement at subsidized rates.
- Construction cost in Telangana capped at Rs 1294 per sqft against the market rate of Rs 1800 per sqft. Rajasthan –Rs 1200 per sqft and Karnataka at Rs. 1500 per sq ft. while the market rate is at least Rs 400 per sqft higher.
Risks……

Incentives without performance requirements may not perform –

• States working with fixed layout or design template and prioritizing materials for fast-pace construction.

• Cities/states need to identify the cost of design and materials that perform and facilitate

• Information on performance of new materials to be augmented -- Thermal comfort should be central to technology choices

• Need materials and construction cost benchmarks to understand the impact of new walling technologies

• BEE - energy demand in buildings can be cut down by up to 40% by designing an efficient envelope.
New walling technologies and impact on beneficiaries

In an emerging construction sector

Expensive new walling technologies bear a high risk of increasing beneficiary’s household energy expenditure
Rental housing: An opportunity

Private public entity to construct, maintain and operate rental housing

Fiscal strategy – Income tax exemption, Profit and gains from operations, GST exemption, low interest rates. ULBs to provide infrastructure support

Asks for “speedier, sustainable resource efficiency and resilient construction”, structural stability, basic civis infrastructure, Waste water treatment, rain water harvesting, solar power etc.

(Model RFP, Experssion of Interest, MOU between GOI and States etc)

Additional Technology Innovation grant for innovation and alternate technologies – to be completed within 18 months after approval

How to reinforce thermal comfort requirements in this paradigm?
Stage 1: Three compendiums launched in 2016, 2017 and 2018 respectively

Stage 2: Global Housing Technology Challenge (GHTC) is launched as a mission to leverage the success of PMAY and its technology sub-mission and also to invite more construction technologies

Stage 3: Construction of Light house Projects to serve as live laboratories
Demonstration of alternative technologies

- **Real housing project:**
  - Min. 1000 houses
  - Two hectare of land
  - Time Limit: 3 months for design and 12 for construction

- 54 alternative materials and technologies classified into 6 groups.

- One technology from each group was assigned to LHPs:
  - Pre-cast concrete (on-site assembly) – Chennai
  - Pre-cast concrete (3D pre-cast volumetric) – Ranchi
  - Monolithic concrete system – Rajkot
  - Prefabricated Sandwich panels – Indore
  - Light Gauge Steel & pre-engineered steel structural system – Agartala
  - Stay in-place formwork – Lucknow
  - Global housing technology challenge

Source: https://ghtc-india.gov.in/
September 2015: Multi-attribute evaluation methodology for selection of emerging technologies

1. Mandatory Attributes (PA)
   1.1 Strength and Stability Requirements (SA)
   1.2 Performance and Statutory Compliance (SA)
   1.3 Fire Resistance (TA)
   1.4 Thermal Comfort (TA)
   1.5 Acoustic Performance (TA)
   1.6 Weather-Resistance (TA)
   1.7 Water Tightness (TA)

2. Preferred and Desired Attributes for Evaluation of Emerging Housing Technologies (PA)
   2.1 Functional Requirements (SA)
   2.2 Constructability (SA)
   2.3 Economic Viability (SA)
   2.4 Maintenance (SA)
   2.5 Sustainability (SA)
   2.6 Finish Quality (SA)

The booklet mentioned Thermal comfort as a mandatory attribute

September 2018: Compendium of perspective emerging technologies for mass housing

The booklet mentions Thermal comfort as a preferential attribute,
How to finance thermal comfort using better materials, designs and walling technologies?

**Increased costs:** Combined impact of material choices and architectural design solutions can increase incremental cost by about 20-35% compared to conventional construction (depending on construction costs and material penetration in states).

Developing thermal performance criteria is crucial

Link subsidies and incentives with performance of the housing stock

Integrate regulatory instruments like EIA, building byelaws, etc. with thermal performance criteria.

Need disclosure systems

**Further research avenues**

**Carbon impact framework for the housing construction sector**
Next steps

• Guide the housing sector on alternative material and construction technologies

• Promote adaptive thermal comfort standards

• Need strategies to minimize cost of improving thermal comfort and new construction technologies. Otherwise beneficiary will end up paying the operational cost.

• Shift policy focus from only constructing the housing stock to green performance and lowering of operational cost burden for beneficiaries

• Need improved criteria for assessing affordability establishing affordable housing price-to-income ratios in cities in the post COVID-19 scenario

• Need instruments of accountability and a disclosure system for availing incentives
Need better understanding of affordability

- **National Housing Bank’s RESIDEX** is India’s Housing Price Index (HPI)
- Based on information collected from 50 cities in 21 Indian states
- Two indices:
  - HPI at assessment prices: uses lenders’ valuation data received from banks
  - HPI at market prices for under-construction housing units: uses primary market data for under-construction properties, collected from developers, builders and brokers
- Housing prices are classified on the basis of carpet area size at the city level for units under three size categories: lesser than 60 sqm, 60–110 sqm and more than 110 sqm

**Price-to-income ratio**: median house price divided by annual median household disposable income

**Challenge**: Paucity of data on household income and household expenditure at city level

Source: IDFC Institute, 2018