Roof Over Our heads

A global campaign

BUILDING WORKER RESILIENCE THROUGH CLIMATE-RESPONSIVE HOUSING

Improving thermal comfort, health and wellbeing in worker colonies

Migrants Resilience Collaborative (MRC) & Roof Over Our heads (ROOH)

GURGAON I THANE I HYDERABAD

SPARC NIRMAN MIGRANTS RESILIENCE COLLABORATIVE People's Courage International

Existing conditions

Thane

Gurgaon

>> Aged tin sheets clad the walls on all sides, increasing indoor heat through heat transfer

>> Indoor temperature readings up to **52.2 C**

>> Indoor humidity readings up to **98%**

>> Frame structures have sustained corrosion over time, necessitating maintenance

>> Materials used do not work for common cooking facilities due to high heat and soot deposition

>> Flooring: The temporal nature of the sites have reduced attention to the flooring conditions; lacking tiles and finishing, usable space indoors is highly constricted, especially for family units

>> Limited opportunities for the installation of ceiling fans and other appliances for cooling due to weak frame structures

>> Lack of openings due to the materials used and water seepage issues when cut-out

>> High heat index during the night, reducing sleeping hours and comfort

>> Cooking activities in family units, leading to trapped heat

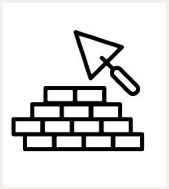
Feasibility of materials: Some considerations

Feasibility in terms of structural strength:

- Age of materials used for the walls
- Condition of materials used for the walls
- Nature of materials used for the walls

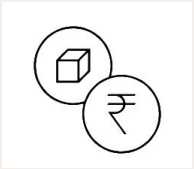
Local, regional and national market gaps:

- Availability,
- minimum stock protocols
- Lead and Lift
- Restricted skill sets



Labour and construction ecosystem:

- Knowledge and experience gaps
- Tool gaps



Cost and finances:

- Cost of material
- Cost of skilled labour
- Access to credit: Opportunities and barriers

	What people can do	What markets have tried but is not enough	Material combinations that are adaptable and scalable	What needs to shift
 **Roofing** Costs are by Sq.ft based on market standards	**(10 ~ 25/ sq.ft)** EPS (Thermocol) + Corrugated Tin sheet + Thatch/ Piri Grass + Palm Boards + Cardboard/ Plastic/ Neoprene + Al-Zn corrugated sheet + Plywood sheet + Corrugated Cement sheet + Alufoil sheet + MDF. Materials that do not work, have low longevity, are highly susceptiple to damage over shorter durations	**(25 ~ 45/ sq.ft)** PPGI Sheet roofing + XLPE insulation + Rockwool insulation + FRP Roofing sheet. Materials that can work in combination with others but by themselves may prove inadequate over a period of time	**(45 ~ 80/ sq.ft)** PPGI Sheet roofing + XLPE insulation + Solar Reflective Paint (Luminx); PPGI Sheet roofing + Rockwool insulation + Solar Reflective Paint (Luminx); UPVC sheets; Sand-coated Aluminum Sheets; PPGI+XLPE insulation roofing. Combinations and manufactured solutions that work	**(100+/ sq.ft)** PUF insulation panels + Onduline panels + RCC 3500+/ Sq.ft. Materials that are unattainable in the context of informality
 **Walls** Costs are by Sq.ft based on market standards, 10ft height coverage for a 10x10ft dwelling	**(30 ~ 150/ sq.ft)** Tarpauin, Neoprene and Miscellaneous plastics + Sheet Metal Plywood + PPGI Sheet roofing Cement sheet. Materials that do not work, have low longevity, are highly susceptiple to damage over shorter durations	**(275 ~ 375/ sq.ft)** Red bricks + Fly-ash bricks + AAC blocks. Materials that can work in combination with others but by themselves may prove inadequate over a period of time	**(375 ~ 500/ sq.ft)** Red-bricks + Lime based plaster + Mud and cowdung plaster; Fly-ash bricks + Lime based plaster + Mud and cowdung plaster; AAC blocks + Lime based plaster + Mud and cowdung plaster; Red-bricks + Lime based plaster + thermocol (EPS); Red-bricks + Fibre cement boards + thermocol (EPS). Combinations and manufactured solutions that work	**(800+/ sq.ft)** Rapicon Panels (Includes all skilled labour cost). Materials that are unattainable in the context of informality
 **Floor/Plinth** Costs are by Sq.ft based on market standards	**(25 ~ 50/ sq.ft)** Bare earth, Plastic sheets, carpets + PCC/IPS + Kota Stone. Materials that do not work, have low longevity, are highly susceptiple to damage over shorter durations	**(50 ~ 75/ sq.ft)** PCC + Oxide coating. Materials that can work in combination with others but by themselves may prove inadequate over a period of time	**(75-120/ sq.ft)** PCC + Ceramic tiles; PCC + Terracotta tiles; PCC + Semi-vitrified terrazzo tile; Tile pasting epoxy + Plastic cooling tiles. Combinations and manufactured solutions that work	**(150+/ sq.ft)** Marble flooring. Materials that are unattainable in the context of informality

Demonstration strategy

Material priorities

Minimal disruption to existing structures: A focus on retrofitting

Emphasis on cladding and layering: The use of Solar reflective paints and lightweight thermal insulation

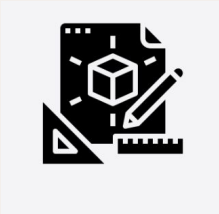
Localised replicability

Temporality and dismantability

Design considerations

Ventilation: Strategically placed openings to reduce indoor humidity and promote air-exchanges

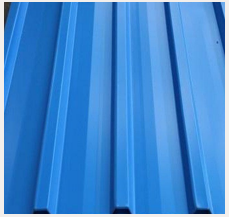
Insulation: to minimise heat transfer from existing metal sheets



Cost considerations

Scalability: Minimising Sq.ft costs, limiting upgrades to 3x-4x that of existing construction costs to keep it within acceptable margins

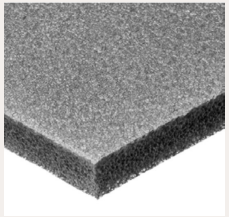
Palette of materials: Workers colony demonstrations



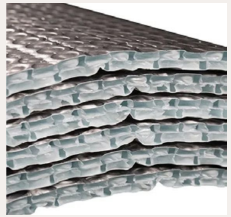
A. 0.5 mm Pre-painted galvanized Iron sheets

B. PUF Insulation Panels

C. Solar Reflective Paint (Luminx) for Walls and Roof



D. PPGI + 13 mm Cross-Linked Polyethylene Foam Insulation



E. PPGI + Aluminium Foil Double Layer Bubble Insulation

F. Gyproc Gypsum Drywall Cladding Boards for Thermal Barrier

G. Aerocon Panel +Exterior Luminx Paint

H. Plastic Tiles for Ceiling

I. PPGI + 50 mm Rockwool Insulation with Interior Aluminium Foil

J. Anti Rust Protective Paint on Metal Structural Sections

Process documentation: high SRI paint application

Left: Preparation, and mixing of the high SRI Paint (Luminx), Right: Application of the high SRI paint on the PPGI roofing units ***Gurgaon***

Process documentation: high SRI paint application

Site workers preparing and applying the High SRI paint manually following a workshop, ***Gurgaon***

Process documentation: Insulation and layering

Replacement of Tin sheets with pre-painted galvanised iron sheets (PPGI), insulation and internal cladding: ***Gurgaon***

Process documentation: frame structure

Left, preparation of the frame structure for the composite walling, Right, application of the anti rust paint, cladding sheets
Thane

Process documentation: Insulation and layering

Installation of the XLPE-Alupet insulation, towards the prevention of heat transfer from the PPGI sheets to the inside: ***Thane***

Process documentation: Insulation and layering

Gyproc (Gypsum) boards being installed to clad the XLPE-Alupet insulation: ***Thane***

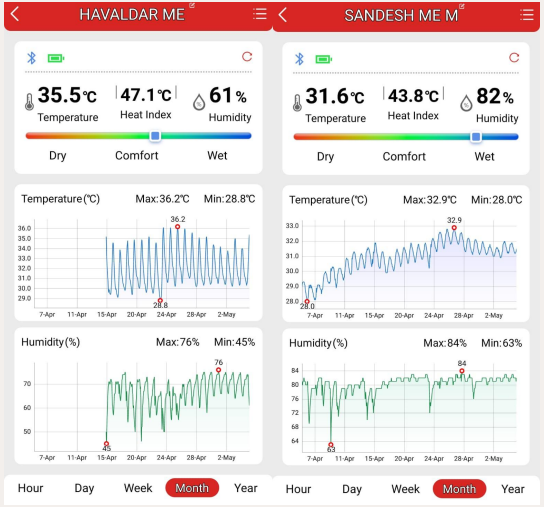
Completed demonstrations: Gurgaon

Security cabin (Left), Housing unit (Middle), 620 sq.ft isolated structure (Right)

In-progress demonstrations: Thane

Left: Cluster of 3 demonstration units, complete with overhead clerestory windows for passive ventilation, Right: internal cladding; Gyproc boards - Alupet Foam - PPGI sheets

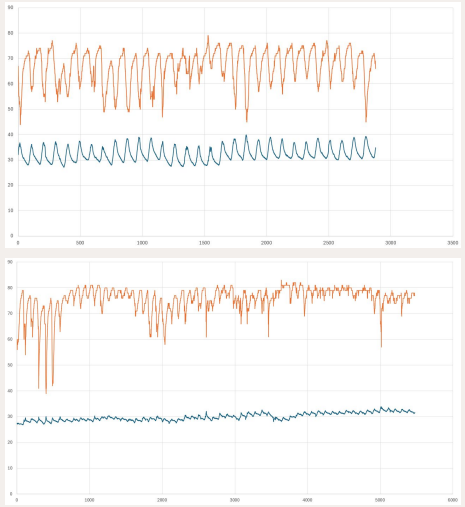
Methodology: Thermal comfort impact assessment



Base data: Temperature and humidity device

House 3_E Block After_Same Typology	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 14th March to April 28	15.2	48	28.8	10	89	46.5	1362 instances	29.0
In Farenheit	59.4	118.4	83.8				340.5 hours	
House 3_E Block L 022 Bachelor_Same Typology Compare	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th March to April 28	15.2	48	29.3	10	89	45.1	1275 instances	29.5
In Farenheit	59.4	118.4	84.8				318.75 hours	
D Block - L006 - Family	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 29	15.2	50.4	28.8	10	88	45.9	1175 instances	29.0
In Farenheit	59.4	122.7	83.9				293.75 hours	
D Block - L011 - Bachelor	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 29	14.8	46.5	30.3	10	86	40	1443 instances	30.0
In Farenheit	58.6	115.7	86.6				360.75 hours	
After paint House L 008 - Bachelor	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 28	15.2	45.2	28.4	10	86	44.4	987 instances	28.4
In Farenheit	59.4	113.4	83				246.75 hours	
After paint House L 002 - Bacehlor	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 28	14.2	44.6	28.1	10	89	45.4	986 instances	28.2
In Farenheit	57.6	112.3	82.5				246.5 hours	
After paint House L 005 - Family	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 28	15	44.3	28.2	10	86	43.4	1001 instances	28.1
In Farenheit	59	111.7	82.8				250.25 hours	
Baseline Outdoor - Block B 07 Center	Min Temp C	Max Temp C	Avg Temp C	Min Hum %	Max Hum %	Avg Hum %	Above 32.3C or 90F	
From 20th march to April 29	13.8	51.6	28.8	10	99	44	1118 instances	28.8
In Farenheit	56.8	124.9	83.8				279.5 hours	

Tabulated data, as exported



Graphs for analysis

Ambient temperature - humidity base data assessment

- Min, max and average temperature
- Min, max and average humidity

Biological markers

- Heat index measurement, aggregate of temperature and humidity
- Standard deviation

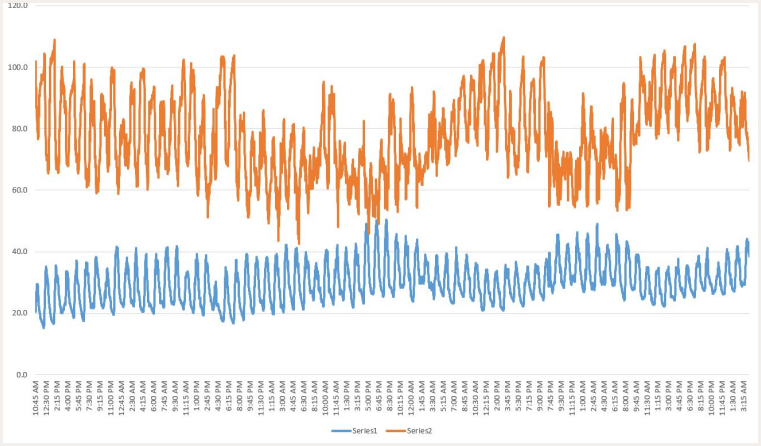
Data and analysis: Tables and graphs

- Comparative tables
- Graphs with time-wise heat and humidity readings for regular cycles at 15 minute intervals
- Psychrometric chart positioning

Initial results: Gurgaon: Monitoring over 72 summer days

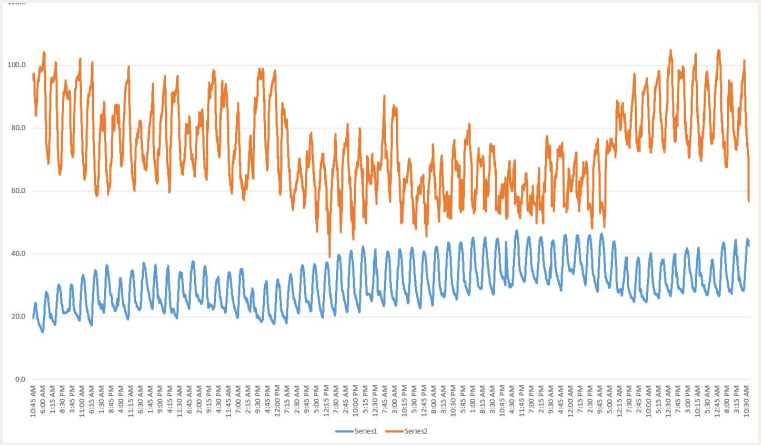
Temperature in C
Humidity in %

Control case: Baseline



Max temperature	**49.7 °C**
Min. temperature	**15.1 °C**
Average Temperature	**30.8 °C**
Average humidity	**45%**
Heat Index (felt temp.)	**31.5 °C**
Hours spent above Thermal comfort threshold (1714 hours)	**666**

Proposal/demonstration



Max temperature	**47.1 °C**
Min. temperature	**14.8 °C**
Average Temperature	**30.4 °C**
Average humidity	**42.6%**
Heat Index (felt temp.)	**30.5 °C**
Hours spent above Thermal comfort threshold (1714 hours)	**525**

Reduced 140 hours of high heat stress, a **21% reduction** achieved at **INR 25/Sq.ft (USD 0.26)**

Maximum temperature Values reduced by **2.8 °C**

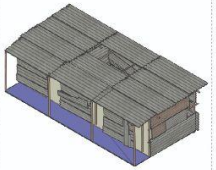
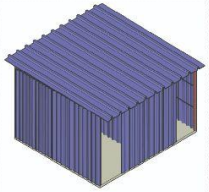
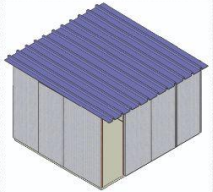
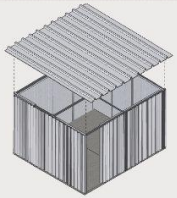
Average Heat index, a measure of temperature as felt, has reduced by **1 °C (Indoor Air temperature)**

Measurable improvements Across **all key metrics**

Reduced temperature variability, improving adaptation comfort and usability

10 °C reduction in roof surface temperature, **3 °C** reduction in the wall surface temperatures

Matrix of demonstrations: Cost v/s thermal performance

	Existing documentation						Demonstration
MRC Sites **Variations in Typologies**	 Thane	 Thane | Gurgaon	 Thane | Gurgaon	 Hyderabad	 Gurgaon	 Hyderabad	 Thane | Gurgaon
Roofing	Tin Sheets in dilapidated condition	PPGI Sheets	PPGI Sheets	Coloured PPGI Sheets	PPGI Sheets	PUF Sandwich Sheet	PPGI Sheets High SRI Cool paint Coating XLPE 13mm Insulation Gypsum Board
Walls	Tin Sheets in dilapidated condition	Tin Sheets in dilapidated condition	PPGI Sheets	Coloured PPGI Sheets	EPS Cement Sandwich Panels	PUF Sandwich Sheet	PPGI Sheets LuminX Coating XLPE 13mm Insulation Gypsum Board
Floor/Plinth	Poured Concrete	PCC	PCC	PCC	PCC	PCC in ground flood Cement bonded particle board in frist floor (CBPB)	PCC Smooth Crete
Cost Per Unit (10 sq. meter) Approx. Ranges	INR ₹15,000 USD $ 159	INR ₹ 20,000 USD $ 212	INR ₹30,000 USD $ 318	INR ₹36,000 USD $382	INR ₹45,000 USD $477	INR ₹75,000 USD $795	INR ₹ 45,000 USD $ 477
Climate performance	Min Temp: 25.1°C Max Temp: 46.1°C Avg. Temp: 33.5°C Avg Humidity: 52.4% Heat index 38.2	Min Temp: 24.9°C Max Temp: 47.6°C Avg. Temp: 33.8°C Avg Humidity: 59.4% Heat index 41.2	Min Temp: 22.3°C Max Temp: 49.1°C Avg. Temp: 33.3°C Avg Humidity: 57.1% Heat index 39.3	Min Temp: 21.8°C Max Temp: 52.2°C Avg. Temp: 34.3°C Avg Humidity: 45% Heat index 37.5	Min Temp: 14.8°C Max Temp: 48.2°C Avg. Temp: 31.8°C Avg Humidity: 41.1% Heat index 32.5	Min Temp: 25.8°C Max Temp: 40.2°C Avg. Temp: 33.2°C Avg Humidity: 48% Heat index 36	Min Temp: 25.8°C Max Temp: 37.3°C Avg. Temp: 30.5°C Avg Humidity: 58.6% Heat index 33.6

Learnings and a way forward

Early Results

- Lower average indoor temperatures
- Lower humidity levels throughout the day
- Reduced heat index
- Fewer hours above thermal comfort threshold

What We Are Learning

- Worker housing is a critical but overlooked climate adaptation issue.
- Extreme indoor heat affects sleep, health, wellbeing and recovery.
- No single material is enough; effective solutions combine reflection, insulation, ventilation and passive cooling.
- Design decisions, made in consultation with the users, are crucial to the optimal use of material combinations
- Practical retrofits can improve comfort without full reconstruction.
- The best options balance **cost, comfort, durability and scalability**.
- Thermal performance can be measured, compared and improved through data.

Way Forward

- Generate evidence on scalable climate-responsive housing solutions for workers.
- Develop practical **SOPs, design guidance and material packages** for worker housing retrofits.
- Work with industry partners to integrate thermal comfort into worker housing standards, site planning and contractor practices.
- Support governments to incorporate worker housing into heat action plans, labour welfare systems and climate adaptation strategies.
- Build affordable adaptation models that balance cost, comfort, durability and scalability.
- Position worker housing as a core component of worker health, productivity and climate resilience.