

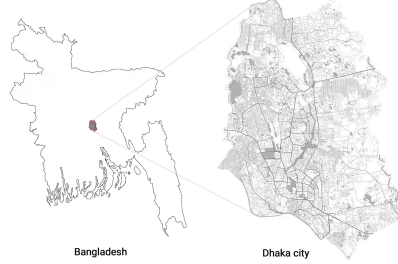
# COOL SURFACES

## ENHANCING LOCAL TECHNIQUES FOR THERMAL COMFORT

Bangladesh, a country severely affected by climate change and rise in sea level, has to accommodate many climate migrants in its densely populated cities. Meanwhile, the average summer temperature in Dhaka city is rising each year, and lower-income people are suffering the most.

The informal settlement at Sattola, Dhaka, Bangladesh, exhibits a UHI effect (found from the generated land surface temperature map) and has high indoor temperatures, as it is crowded with corrugated iron (CI) sheet or tin sheet-built constructions, has no air, and unprotected sunbaked areas. The residents are extremely poor. Therefore, instead of replacing the current typology of tin-houses, this project proposes three passive surface solutions—Cool Floor, Cool Wall, and Cool Roof—to transform a typical dwelling into a heat-adaptive. The design assumes that people living here cannot rely on expensive materials or mechanical cooling systems. So, the proposal uses what are cheap, locally available, and simple to install or can be assembled by local people. Residents of Sattola can add new parts to existing houses gradually. By considering all surfaces as thermal interfaces and not a fixed boundary, as it would be in a conventional settlement, the prototype exhibits a dignified, scalable method of heat-resistance in informal settlements.

### SELECTING THE SITE



### PHOTO-DOCUMENTATION



Multi-story housing system with extended balconies for utility and communal activities



Poor facade condition observed from the outside of the settlement



Various types two-storey of CI sheet (Tin) roof shades and facade windows in the settlement



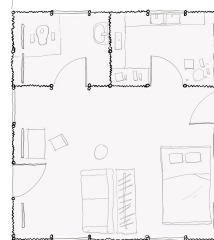
One-storey housing unit with brick-CI sheet hybrid facade system for cutting cost



Conducting interviews & questionnaire survey in front of bamboo and timber-structured housing units

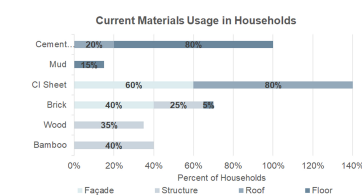
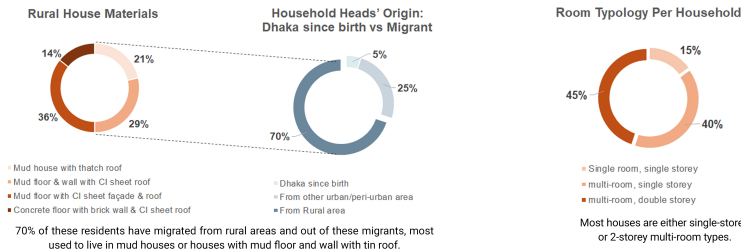


Existing state of the selected case residential unit in the informal settlement

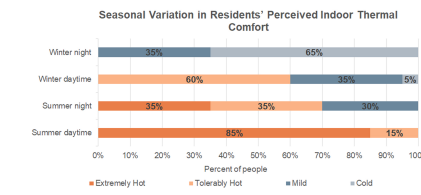


CASE HOUSE LAYOUT (TYPICAL)

### FINDINGS FROM THE SURVEY

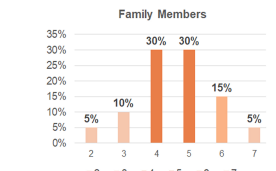


Tin sheet is the most common material in these settlements currently. Almost all houses have Tin roof and most have tin facade. Low use of earthen floor indicates that they tend to forget their past



Most respondents said that their indoors are so heated up during summer that they cannot stay indoors during summer noon. However, they can stay comfortable during winter afternoon. In contrast, the 2-months long winter nights feel cold for many.

Our team visited Sattola after finding a potential UHI there and immediately after the visit, it was considered as the case site. The team investigated the site in detail and conducted questionnaire survey of 20 residents from different households. To make the process more inclusive, the team selected different age and gender as these 20 respondents.



They mostly have 4-5 family members, but 6-7 member families are also abundant.

### ACTIVITY TIME - SPACE OCCUPANCY CHART

User type	4:00 - 5:30 AM	5:30 - 6:30 AM	6:30 - 7:30 AM	7:30 - 8:30 AM	8:30 - 9:30 AM	9:30 - 11:30 AM	11:30 - 2:30 PM	2:00 - 3:00 PM	3:00 - 5:00 PM	5:00 - 7:00 PM	7:00 - 10:00 PM	10:00 - 11:00 PM
Employed man	Bed	Toilet/Bath	Eating Space	[WORK]	[WORK]	[WORK]	[WORK]	[WORK]	[WORK]	Dwelling unit	outside	Dwelling unit
Employed woman	Kitchen	Toilet/Bath	Dwelling unit	[WORK]	[WORK]	[WORK]	Kitchen	[WORK]	messon	Dwelling unit	Kitchen	Dwelling unit
Housewife	Kitchen	Toilet/Bath	Dwelling unit	Dwelling unit	Dwelling unit	messon	Kitchen	Eating Space	outside	Dwelling unit	Kitchen	Dwelling unit
Child	Bed	Bed	Toilet/Bath	Eating Space	School/Work	School/Work	School/Work	Eating Space	Play outside	Study/Work	Play outside	Dwelling unit

Most of the time, male income generating member of the household (mostly rickshaw-pullers, van drivers, fruit sellers or labourers) stay outdoors for their work. However, in the late afternoon or evening when they return home, they cannot relax in the tremendous heat during summer.

Working women, who take temporary jobs as maids in higher income households, do not have to stay in this heated indoor environment during noon. However, after coming back, many of them need to do chores or other indoor income-generating activities in an extremely uncomfortable condition.

Most of the time, housewives have to stay indoor for chores and home-based income generating activities. But sometimes they have to go outside when the heat becomes too unbearable indoor in the afternoon.

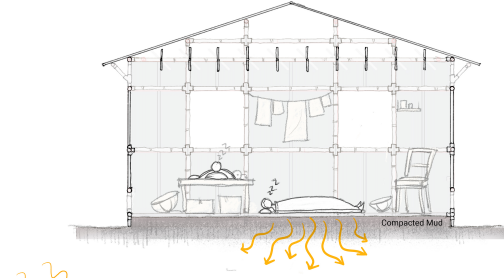
Whether the children/teens work or go to school, they spend most times outdoors.



## DESIGN CONCEPTS (COOL SURFACES)

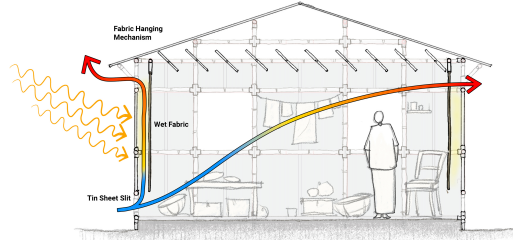
### Cool Floor

Cool floor involves the use of compacted mud where advantage is taken of the naturally wet soil around the pond. The earthen floor, which serves as a thermal sink, takes body heat directly by being in direct contact with the person performing the action, a practice which has its origins in the rural Bangladeshi culture.



### Cool Wall

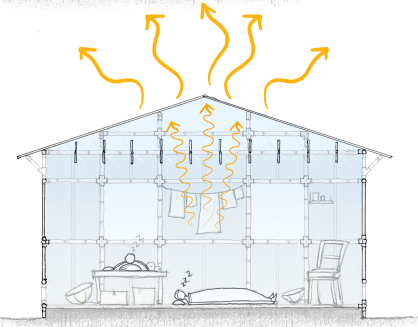
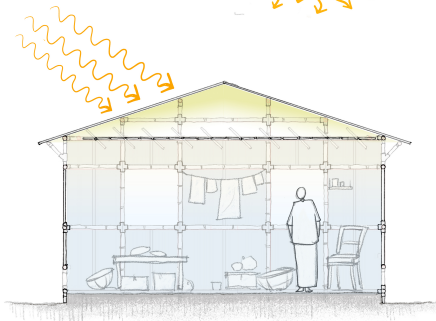
Cool Wall recycles the tin coating whereby the bottom and top have vents cut in them together with a wet cloth layer composed of either local jute or recycled cloth. Southern Air coming in via the lower slit moves through the wet fabric, cools via evaporation and leaves the heated air via the upper slit creating a continuous passive air cycle.



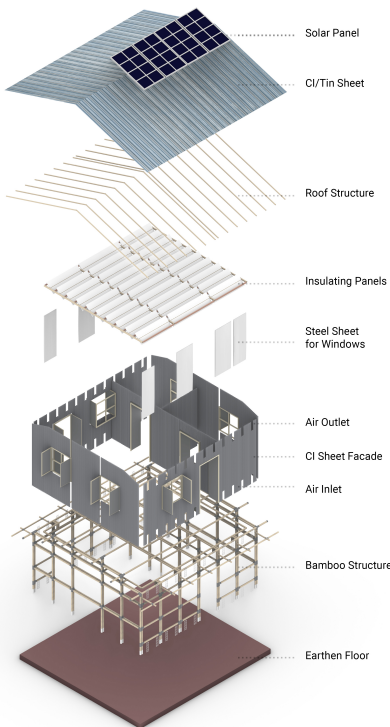
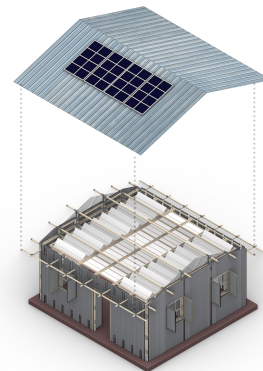
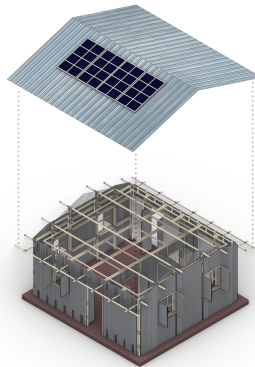
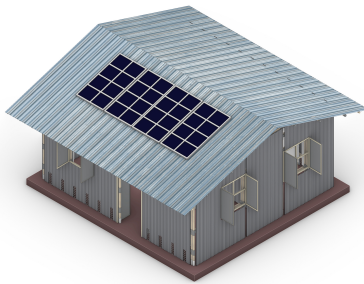
### Cool Roof

Cool Roof deposits an operable insulated layer of louvered insulated sheet below the sheet. On the daytime, the closed louvers create a two-layered roof structure, in which hot air could escape via gables opening. During night, the louvers can be opened and the radiative heat loss via the tin roof is quick and widely serves to enhance comfort in the house during sleep.

The inner insulating panels can rotate, kept horizontal during the day to block heat, and opened vertically at night to let cooler air circulate. This system not only reduces heat transfer from the roof but also allows residents to actively control airflow, making the indoor environment more comfortable and adaptable to changing temperatures.

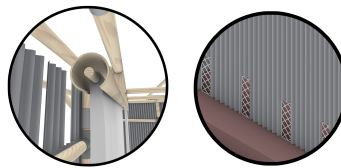


## DESIGN DETAILS



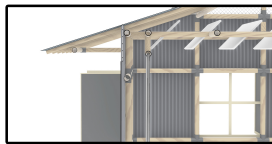
Roof up Axonometric View

Roof up Axonometric View with Pivoting Mechanism



Fabric Hanging Mechanism

Air Inlet (Tin Sheet Slit)

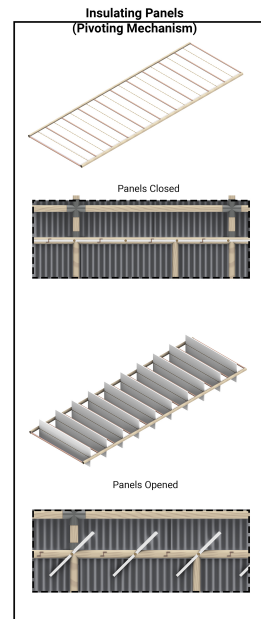


Section showing Mechanism of Cool Wall



Integrated Piping System with the Hanging Fabric

The woven local cotton cloth in front of the tin sheet is hung from a specially cut bamboo and integrated with a piping system connected to a tap. When the tap is operated, water wets the fabric and the water droplets are collected for watering plants or other activities.



Insulating Panels (Pivoting Mechanism)

Panels Closed

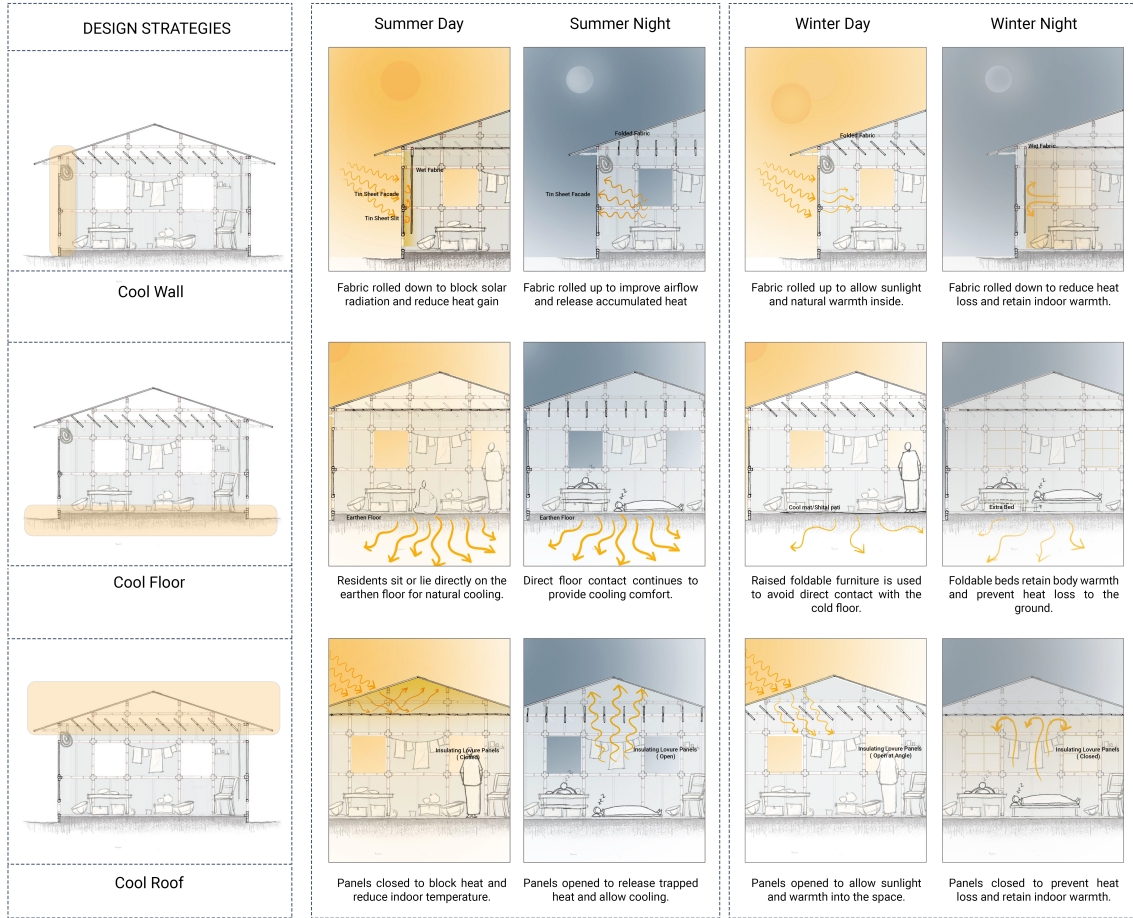
Panels Opened

Exploded Axonometric View

## Climatic Response & User Control

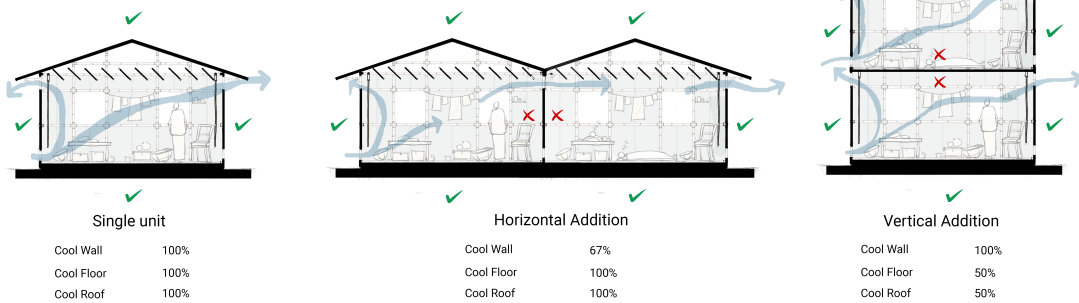
Considering the seasonal weather changes in Bangladesh, we developed a simple user-based system for the Cool Wall, Cool Roof, and Cool Floor. This allows residents to manually adjust their homes for both summer and winter conditions. Our project focuses not only on making indoor spaces comfortable during the hot, dry summer but also on adapting homes for the colder winter season. The seasonal operation matrix illustrates how these three strategies can be adjusted throughout the day and year.

In summer, the wall fabric blocks heat, roof panels prevent heat gain, and the earthen floor provides natural cooling. At night, the system releases trapped heat while maintaining comfort. In winter, the wall and roof allow sunlight and warmth in during the day, while foldable furniture replaces direct floor contact to avoid cold. At night, the panels and fabric are closed to retain warmth, ensuring year-round comfort. This matrix demonstrates how a simple, low-cost, fully passive system can provide year-round thermal comfort in informal settlements.



As this settlement in Dhaka continues to grow rapidly, we considered the possibility of incremental expansion over time, both horizontally and vertically. In a single housing unit, the Cool Roof, Cool Wall, and Cool Floor operate together as an integrated passive system to improve thermal comfort. However, as horizontal growth occurs and units are added side by side, certain limitations emerge. The shared interior wall between adjacent units no longer receives direct solar exposure, meaning the Cool Wall strategy becomes inactive on that surface and remains effective only on the exterior exposed walls. Similarly, in vertical expansion, when an additional floor is constructed above, the upper level loses direct contact with the ground. While the ground floor continues to benefit from the earthen Cool Floor acting as a thermal sink, the upper floor does not receive this cooling advantage. By acknowledging these changes, the project ensures that the passive strategies remain realistic, adaptable, and responsive even as the housing units evolve over time.

## House Unit Extensions



## Cost Estimation

Materials Cost Estimate (6mx6m Tin + Bamboo House)

Assumptions  
Tin rate (per sqm) 5,400  
Tin quantity (sqm) 14.3

Item	Unit	Qty	Avg. Rate (BDT)	Amount (BDT)	Amount (Euro)
GI/Tin sheets (roof + wall) 0.32mm	বর্গ (bundle)	14.3	5,000	71,000	711
Ridge cap / flashing (lump)	LS	1	5,000	5,000	36
Bamboo poles (posts + framing + roof)	pcs (avg)	60	475	28,500	202
GI fittings 1.25" (36 elbow, 13 T, 40 cross, and 10 union)	pcs (avg)	112	150	16,800	119
Fasteners + binding (screws, nails, GI wire, rope)	LS	1	10,000	10,000	71
Door timber frame with tin	pcs	2	8,000	16,000	114
Window timber frames (900x900)mm with SS sheet	Nos	4	2,500	10,000	71
Earthen floor (level + compact)	Nos	1	3,000	3,000	21
				<b>189,400</b>	<b>1,344.74</b>
				Contingency (10%)	134.47
				<b>208,340</b>	<b>1,479.21</b>

The provided cost reflects the construction of a full new house. However, since our concept focuses on retrofitting existing homes rather than rebuilding them entirely, the actual implementation cost would be significantly lower than this estimate.

## Observations

This project demonstrates that simple surface retrofits can significantly improve thermal comfort in informal housing. By introducing three add-on strategies – a mud floor, an evaporative cool wall, and an operable insulated roof – the typical tin house can be transformed into a passive climate-responsive system. These interventions rely on local materials, low-cost techniques, and user-controlled operation rather than mechanical cooling.

Using Sattola as a case study allowed us to test the system within a real, high-density informal settlement in Dhaka. The findings show that thermal discomfort in tin houses is largely driven by heat gain through lightweight surfaces, which can be reduced through targeted material and operational modifications. Although the design is demonstrated in Sattola, the system is not site-specific. Because it works as a modular retrofit rather than a structural replacement, it can be applied in similar informal settlements and low-income housing contexts where tin construction and extreme heat are common.

Overall, the project highlights that small, incremental, and affordable interventions can empower residents to adapt their homes and improve year-round thermal comfort without major reconstruction.