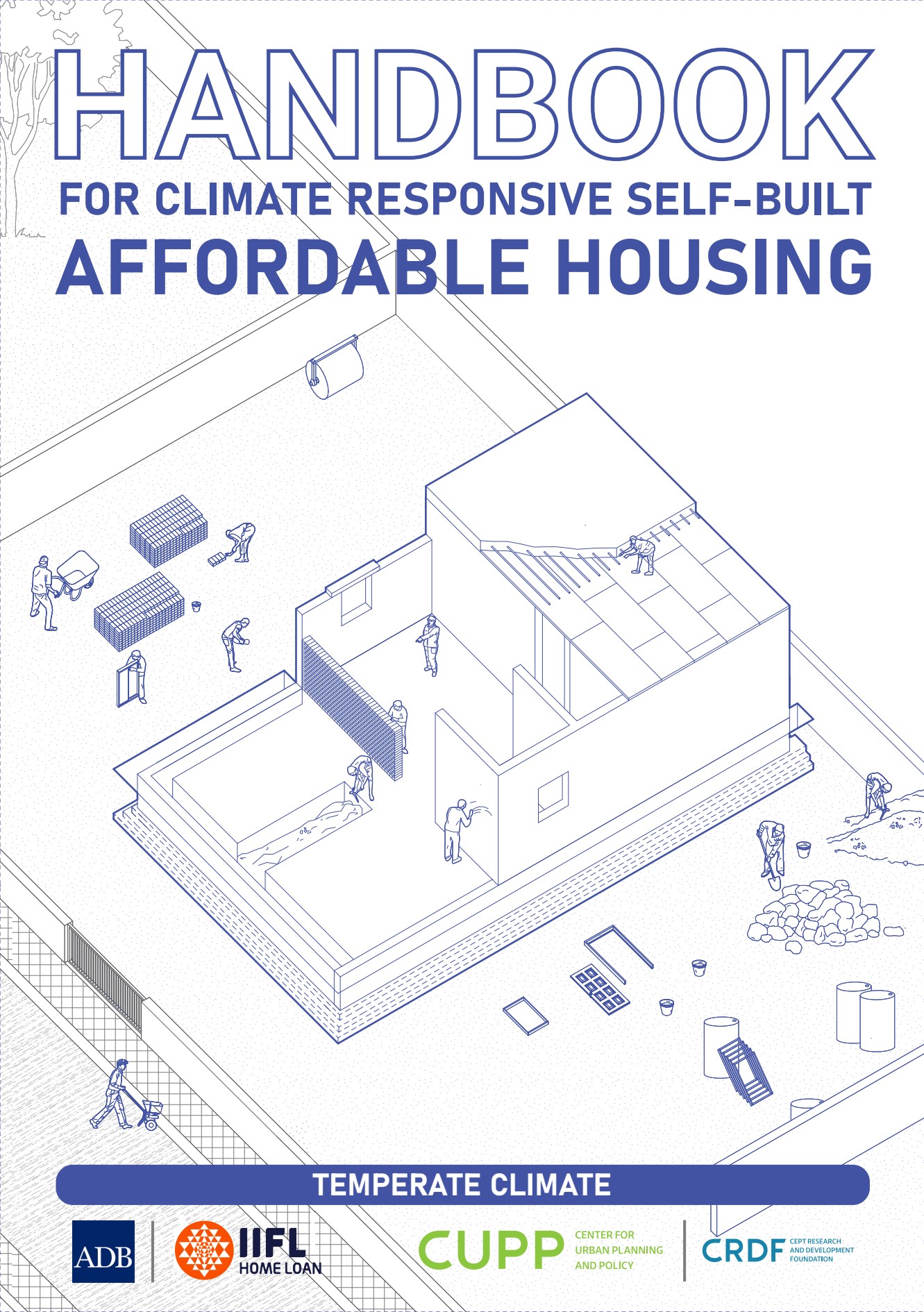
HANDBOOK

FOR CLIMATE RESPONSIVE SELF-BUILT

AFFORDABLE HOUSING



TEMPERATE CLIMATE

ADB | IIFL HOME LOAN

CUPP CENTER FOR URBAN PLANNING AND POLICY | CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION

DISCLAIMER

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Handbook for Climate Responsive Self-Built Affordable Housing

TEMPERATE CLIMATE

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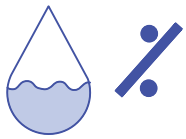
Contents

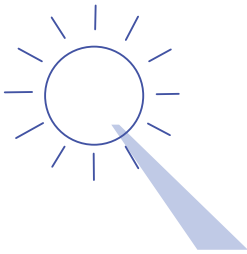
GRAPHICAL GUIDE FOR THE HANDBOOK



Humidity

Rain

Wind

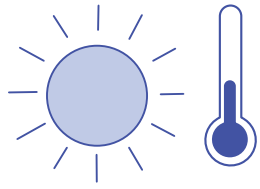


Sunlight

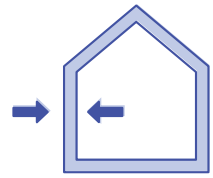
Money / Savings

Air Flow

Cool
Temperature

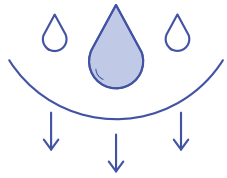


Hot Temperature



Thermal Mass

Compressive
Strength



Water
Absorption

Weight

WHO IS THIS HANDBOOK FOR?

Aspiring Home Owners

This handbook guides homeowners to build a climate responsive house for the geography it is located in while keeping in mind cost efficiency in building construction to make it affordable. The book also suggests sustainable lifestyle choices and practices at home.

Architect / Engineer

Passive architectural strategies with clear design objectives for a particular climate zone given in this book help architects / engineers / technical representatives from HFCs to achieve a sustainable house with ease. Construction details further help in the execution of design goals.

Civil Work Contractor

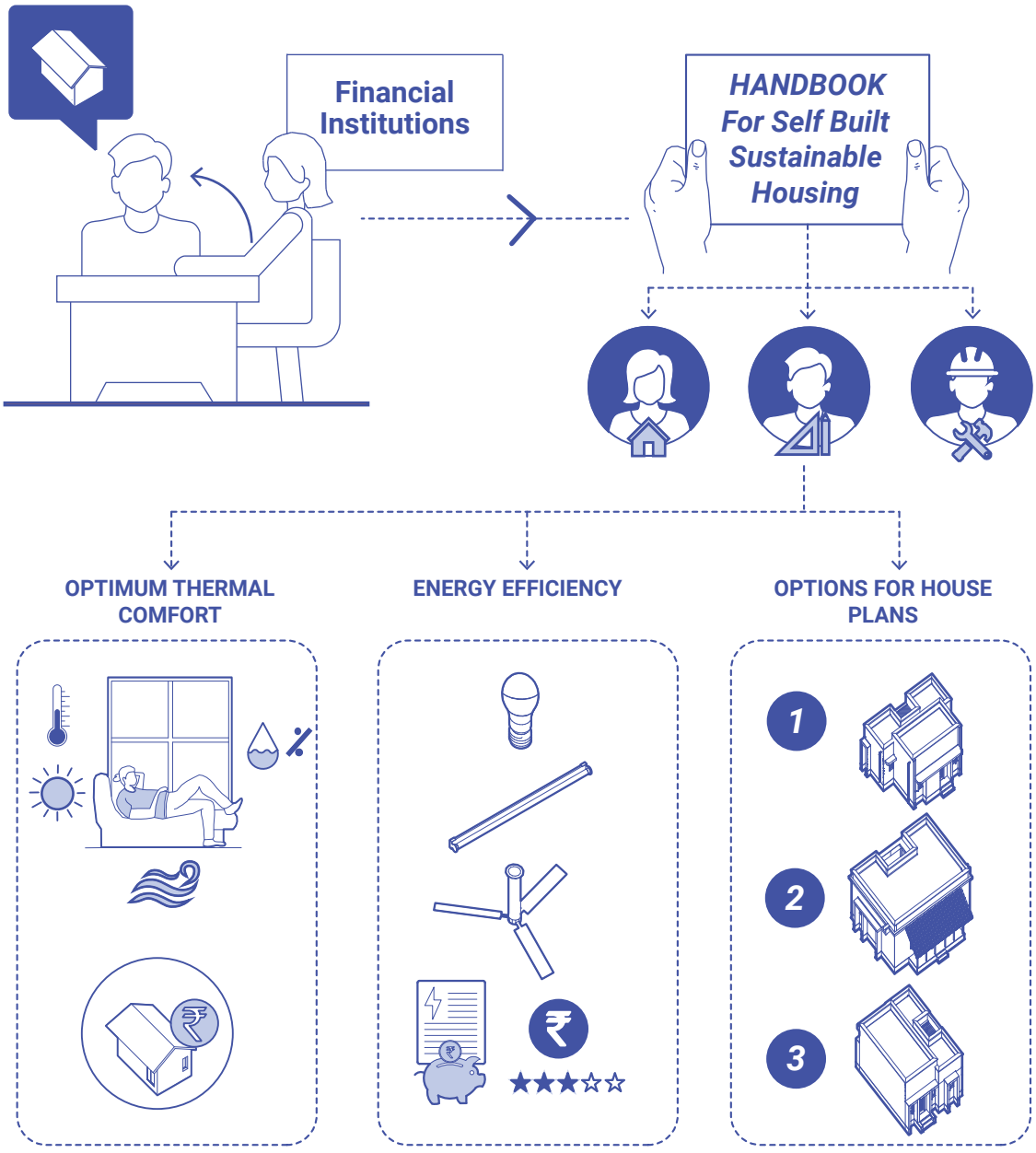
Along with decision making, this handbook works as a reference for building construction on site with its detailed drawings made with precision and clear design objectives towards climate responsive building.

NOTE :

On the top right corner of the page, the icon highlighted in colour depicts for whom the information is applicable.

WHAT IS THIS HANDBOOK ABOUT ?

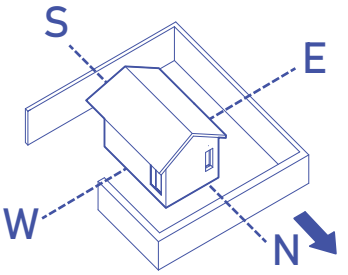
- This illustrative handbook aims to provide guidance to key stakeholders involved in self-built housing (owners, designers and contractors) to develop sustainable affordable homes.
- The handbook lays out design strategies along with solutions for sustainable affordable construction to achieve optimum thermal comfort and energy efficiency in the house.
-It contains plans for three typologies of houses which can be adapted to different site conditions and context. The book also encourages homeowners to choose sustainable appliances and systems at home.



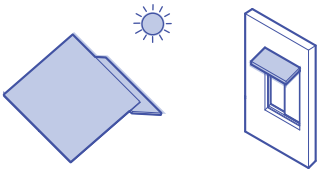
HOW IS THIS HANDBOOK STRUCTURED ?

- This handbook begins with macro-level information about geography and design objectives for the particular climate zone. It further delves into specific passive design strategies (micro-level), construction details, material and appliance choices with the aim of achieving comfortable habitat in the given climate zone.
- It is devised into the following segments:

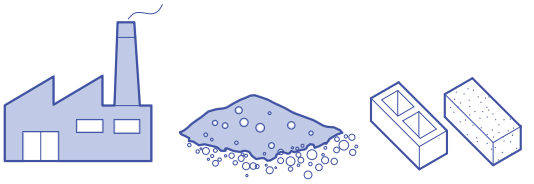
Fundamentals of Temperate Climate



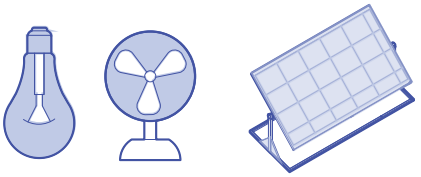
Recommendations at site level



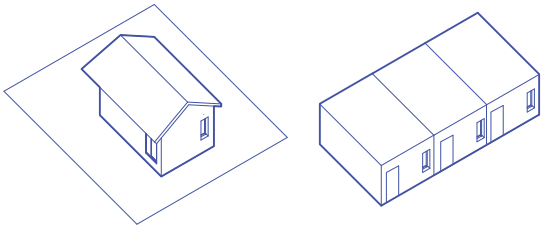
Recommendations at building level



Recommendations for material choices

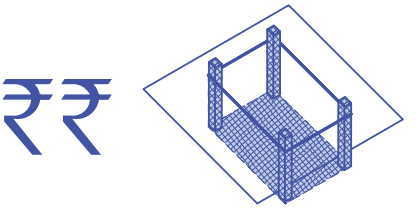


Recommendations for appliances and systems



Unit typologies

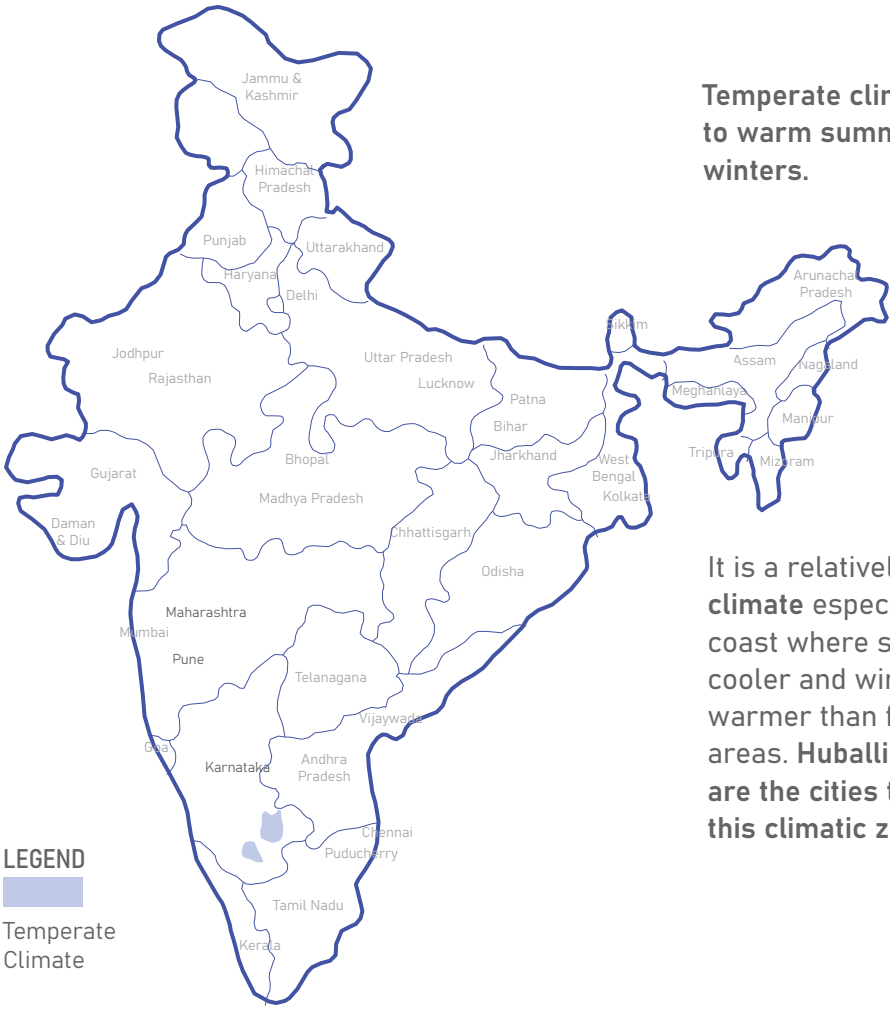
Waste management



Cost estimates for construction

INTRODUCTION TO TEMPERATE CLIMATE ZONE

KNOW YOUR CLIMATE ZONE



Map of India highlighting the **Temperate Climate** region of India

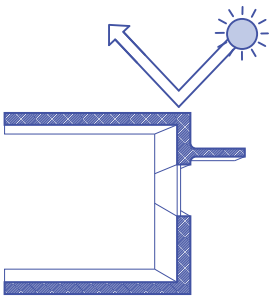
Temperate climate has mild to warm summers and cool winters.

It is a relatively **comfortable climate** especially near the coast where summers are cooler and winters are warmer than further inland areas. **Huballi and Bengaluru are the cities that fall under this climatic zone.**

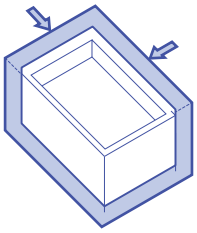
Temperature Range
16 – 34° C
(with little diurnal variations)

High Humidity in monsoon
55% to 90%
Low Humidity for rest of the months **20% to 55%**

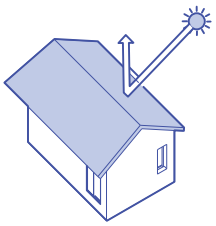
DESIGN OBJECTIVES



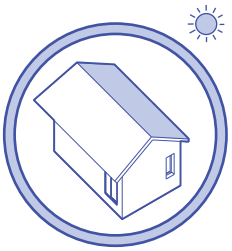
Resist Heat Gain in Summer and Resist Heat Loss in Winter



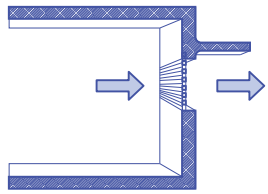
Decrease exposed surface area



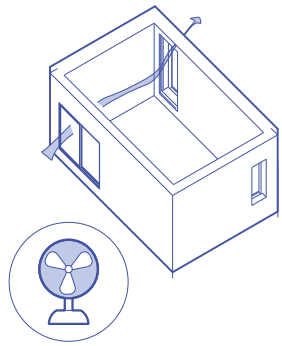
Increase shading and reflectivity



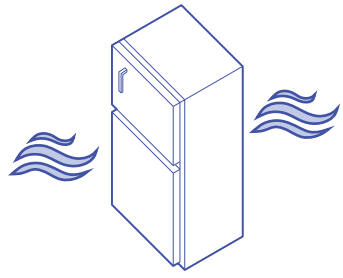
Increase thermal resistance



Promote Heat Loss in Summer and Monsoon



Increasing air exchange rate (cross-ventilation) throughout day.

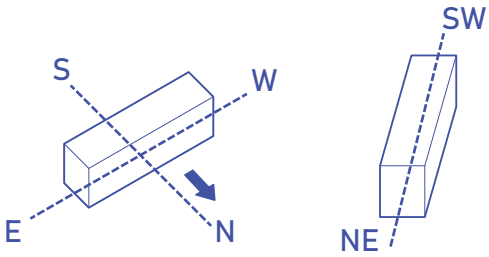


Ventilation of appliances

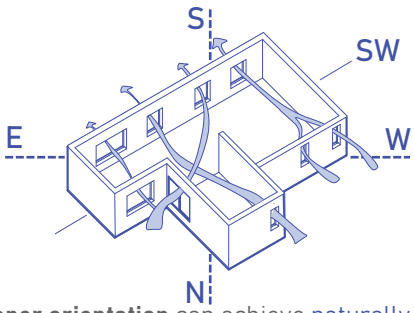
PASSIVE DESIGN STRATEGIES

SITE LEVEL

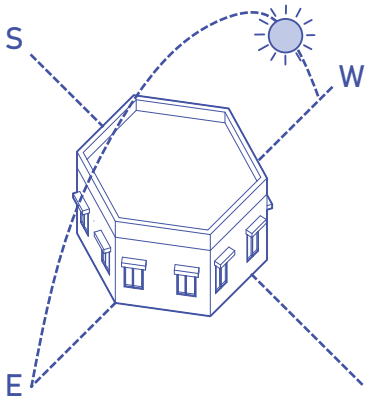
> *BUILDING ORIENTATION*

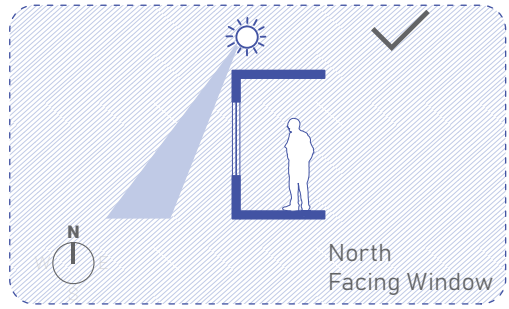


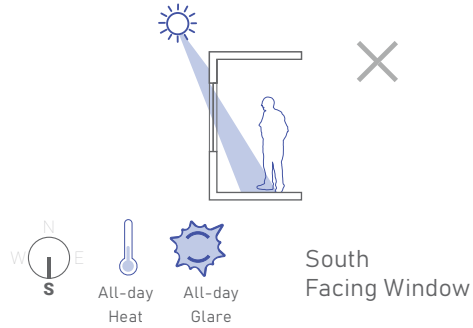
Orientation is the direction the building faces. East-West or **NE-SW** orientation reduces solar heat gain by walls and improves building ventilation.

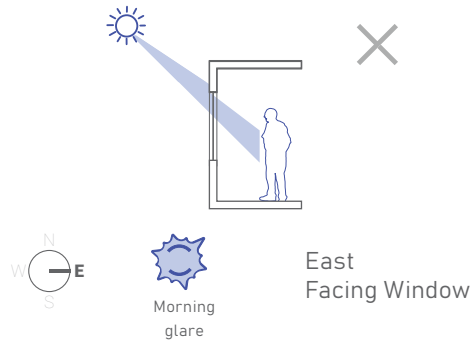


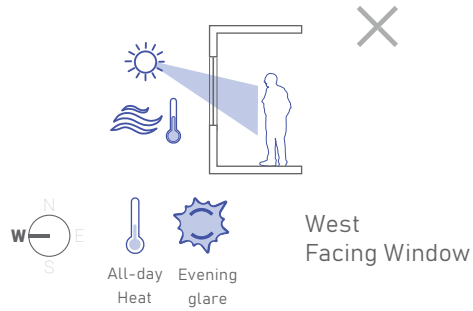
Proper orientation can achieve naturally lit, well ventilated and comfortable rooms.





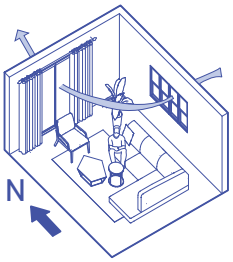




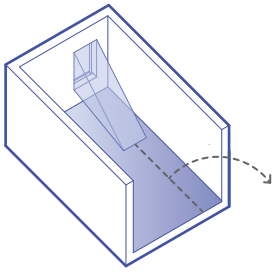


NOTE: For solution, please refer to Page 21

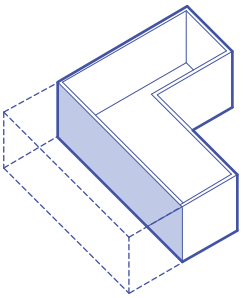
> BUILDING COMPACTNESS



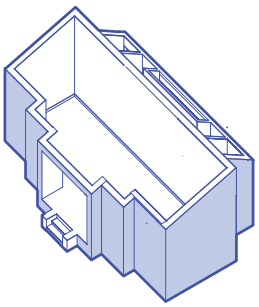
Frequently used spaces that must be well-lit, such as living rooms, should face North-South.



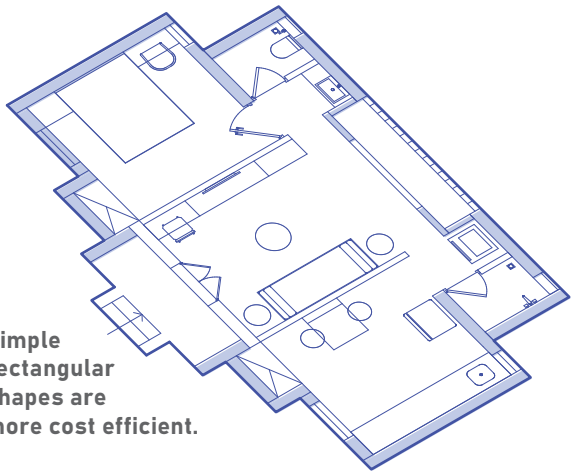
Very **large or deep rooms should be avoided** because the brightness of light diminishes while moving away from a window.



Adjacent units can **share walls** and thereby reduce their exposure to the outside.



The building should be enclosed, compact and inward-looking to reduce sun-exposure.

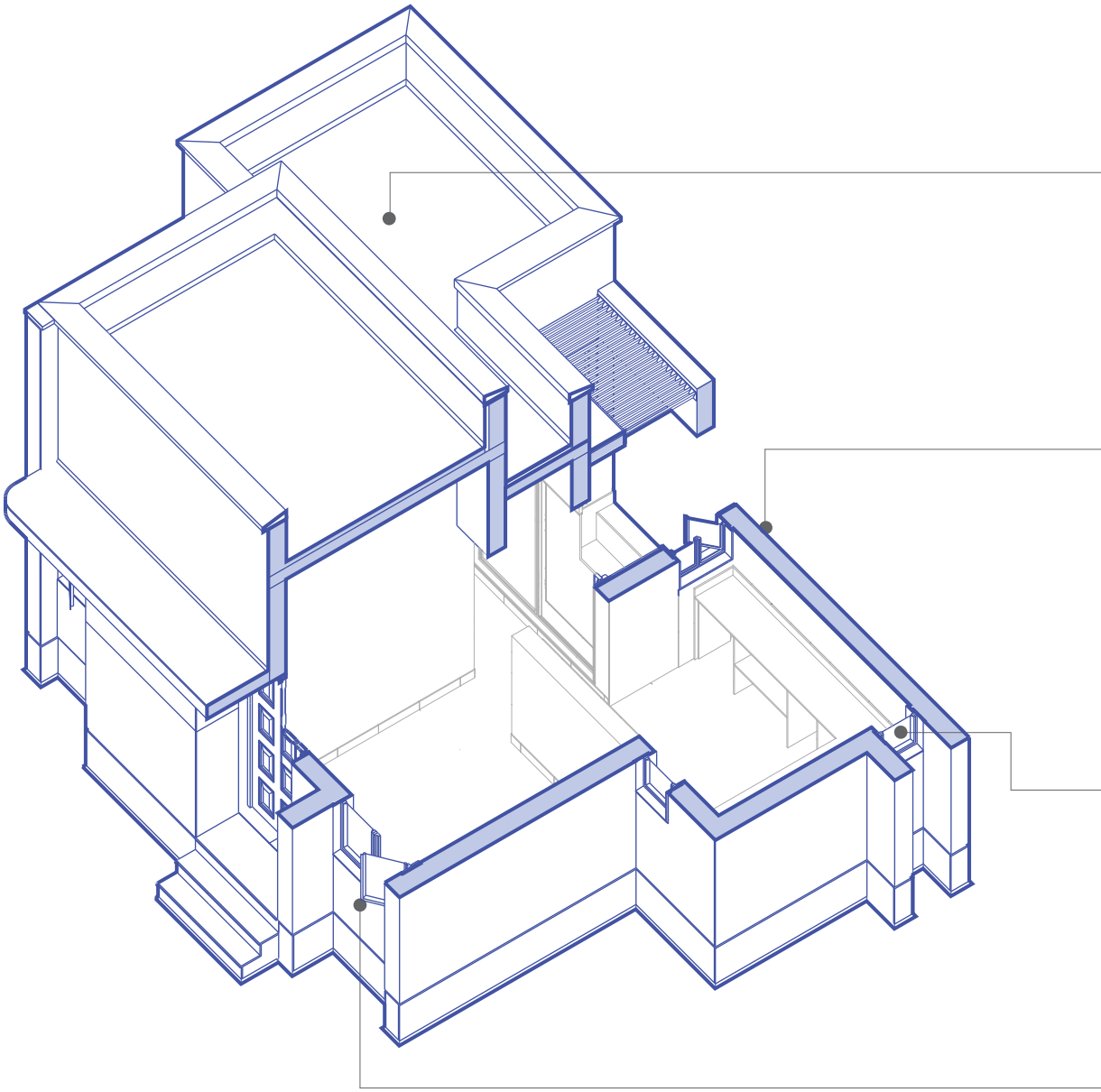


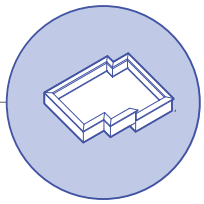
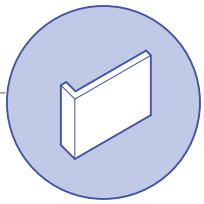
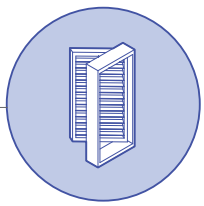
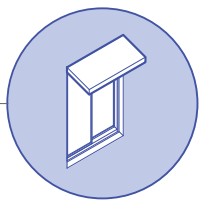
Simple rectangular shapes are more cost efficient.

Simple methods of achieving compactness in planning also reduce the cost of construction.

BUILDING LEVEL

> *BUILDING ENVELOPE*



Building Envelope	Thermal Comfort		
	Natural Ventilation	Shading	Insulation
 ROOF	✓	✓	✓
 EXTERNAL WALLS			✓
 FENESTRATIONS - WINDOW	✓		
 SHADING DEVICES		✓	

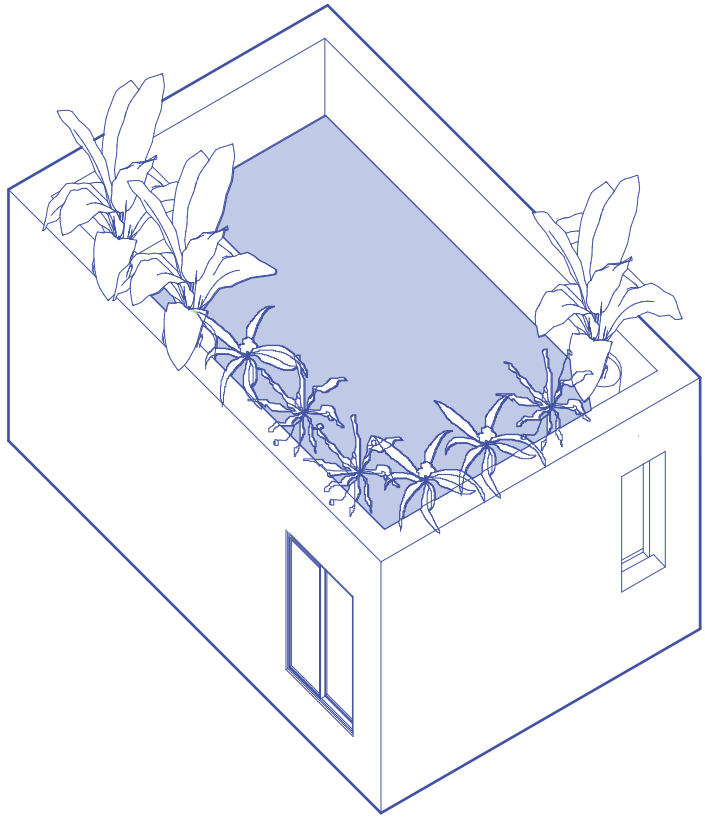
BUILDING LEVEL

> *ROOFING STRATEGIES WITH CONSTRUCTION DETAILS*

OPTION - 1

GREEN ROOF

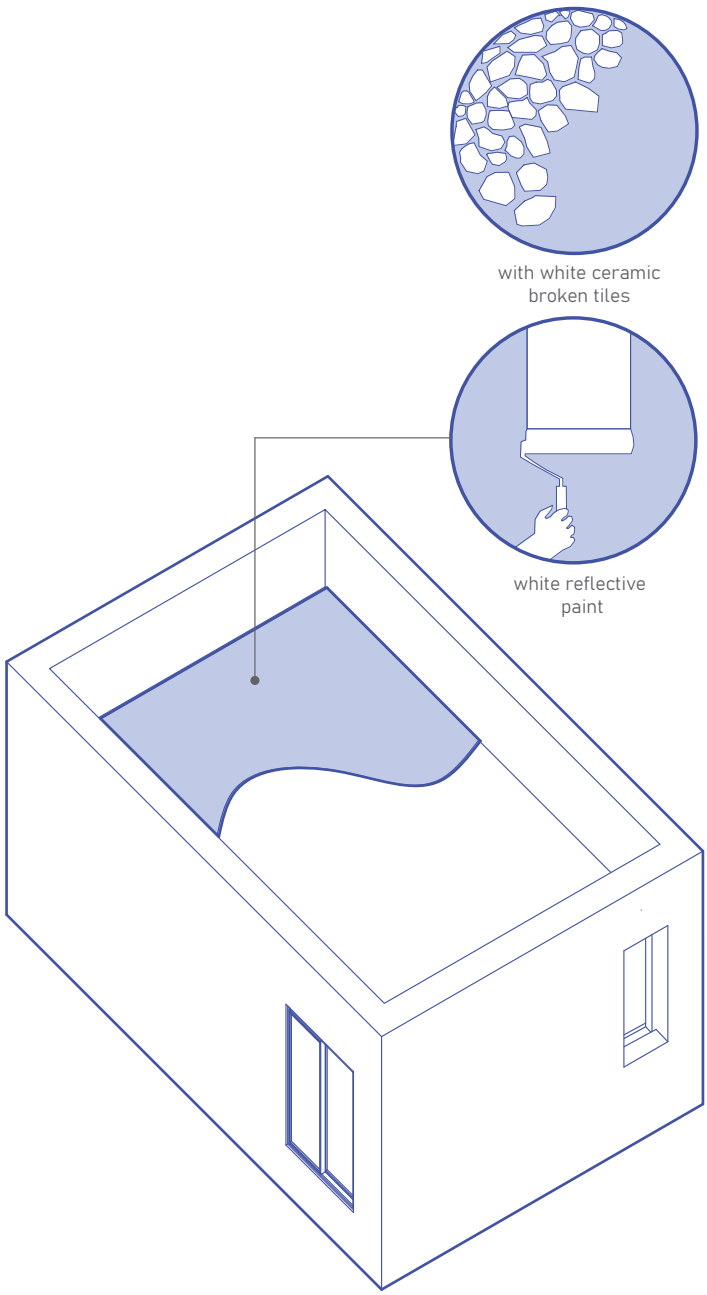
Green roofs are gardens cultivated on terraces. The soil and the plants will help insulate the roof, reducing overall heating and cooling costs. These roofs can reduce the 'urban heat island' effect. In increasingly urbanised spaces, Green roofs also provide easily accessible green spaces.



OPTION - 2

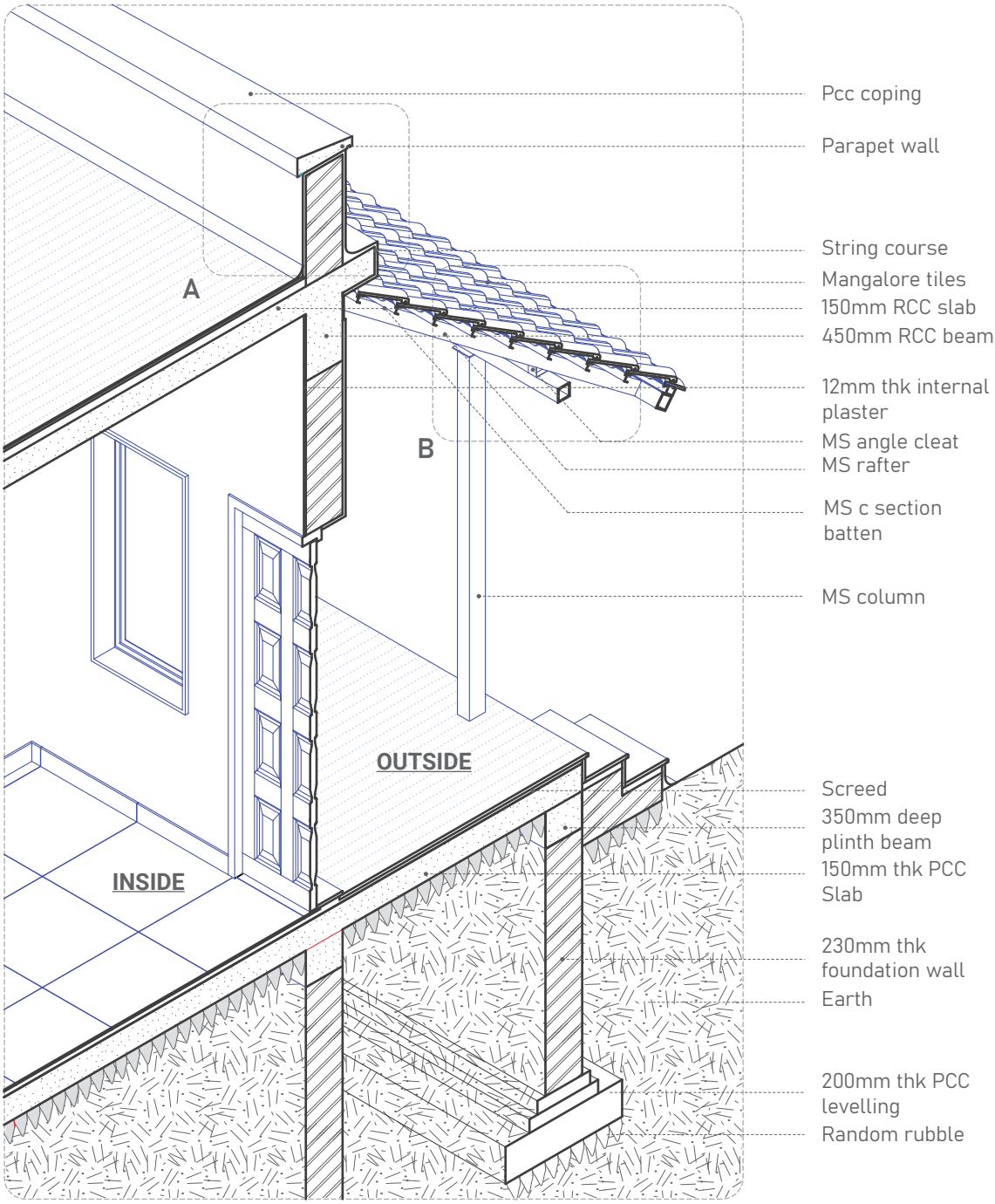
REFLECTIVE SURFACE

Applying white reflective paint on the roof or using white ceramic broken tiles improves reflectivity of the surface. It reduces heat gain and makes the indoors comfortable.

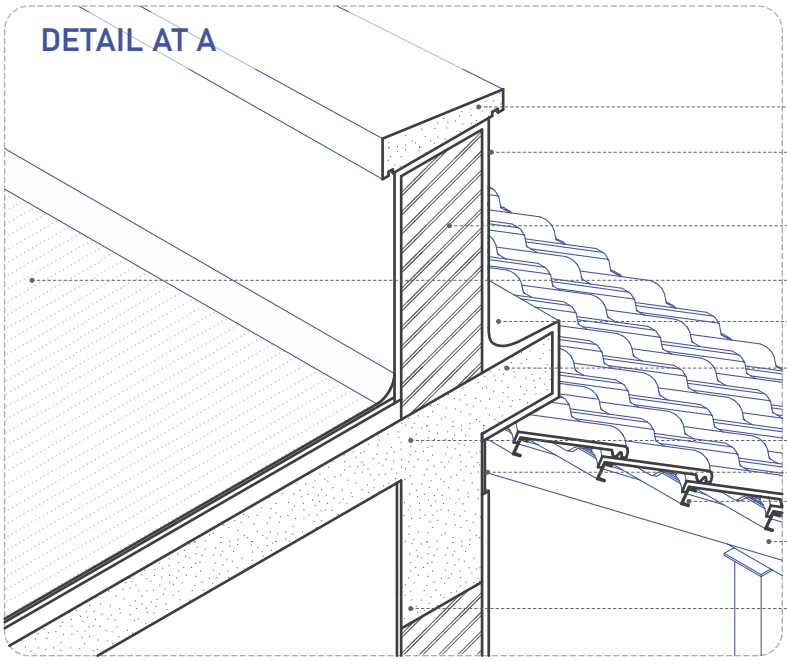


BUILDING LEVEL

> ROOFING STRATEGIES WITH CONSTRUCTION DETAILS

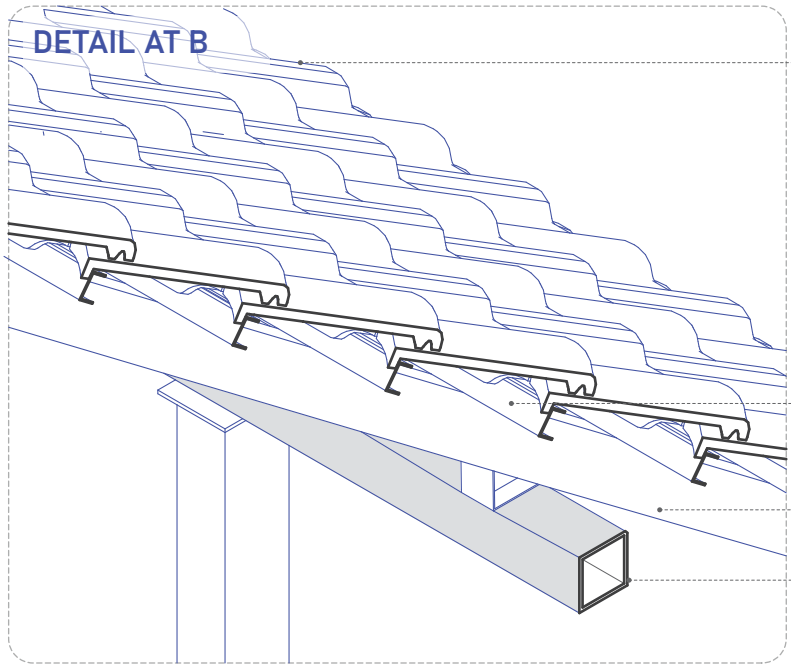


DETAIL AT A



- PCC coping
- 19mm thk external plaster
- 230mm thk parapet wall
- Roof insulation
- Wata
- 150mm thk rcc String course
- 150mm thk RCC slab
- MS plate
- MS C section batten
- MS rafter welded to ms plate
- 450mm deep RCC beam

DETAIL AT B



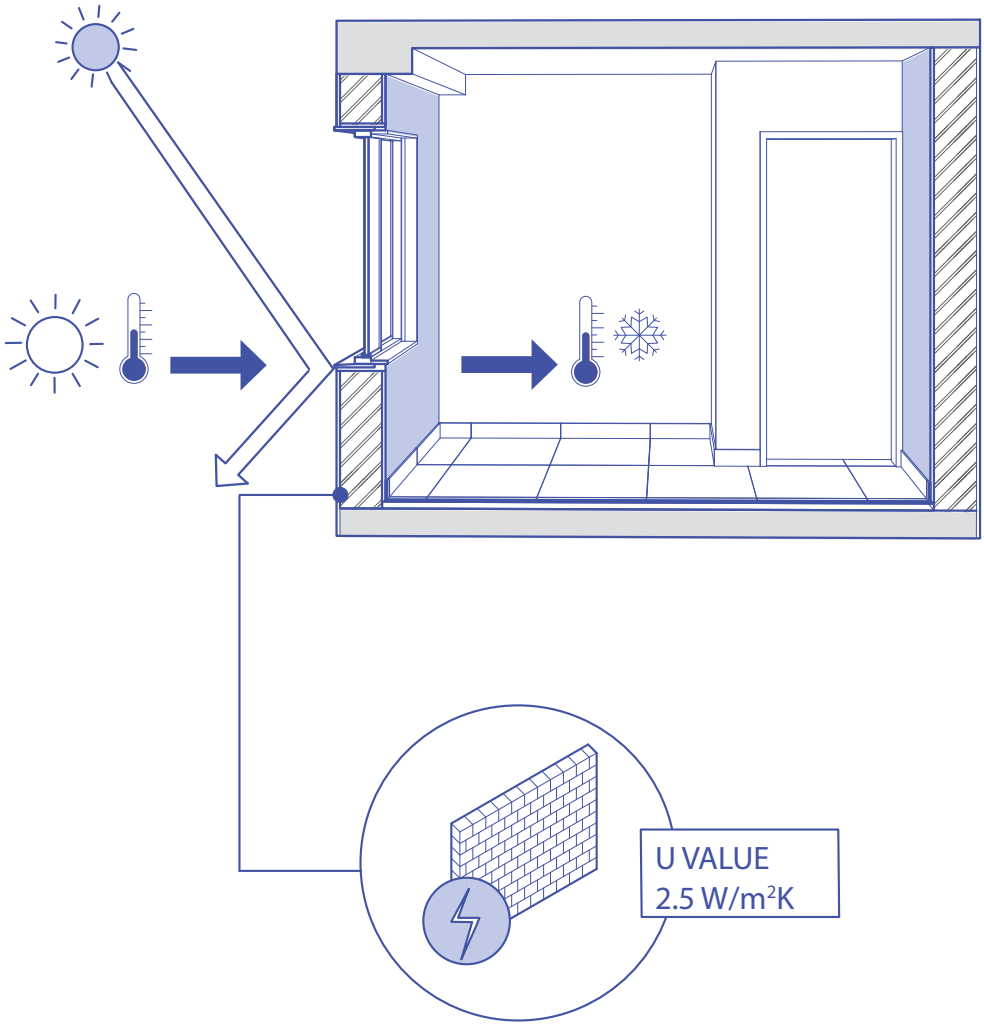
- Sloping roof Mangalore tile
- C section battens
- 50 x 75mm ms rafter welded to ms plate
- 75mm x 75mm ms beam

BUILDING LEVEL

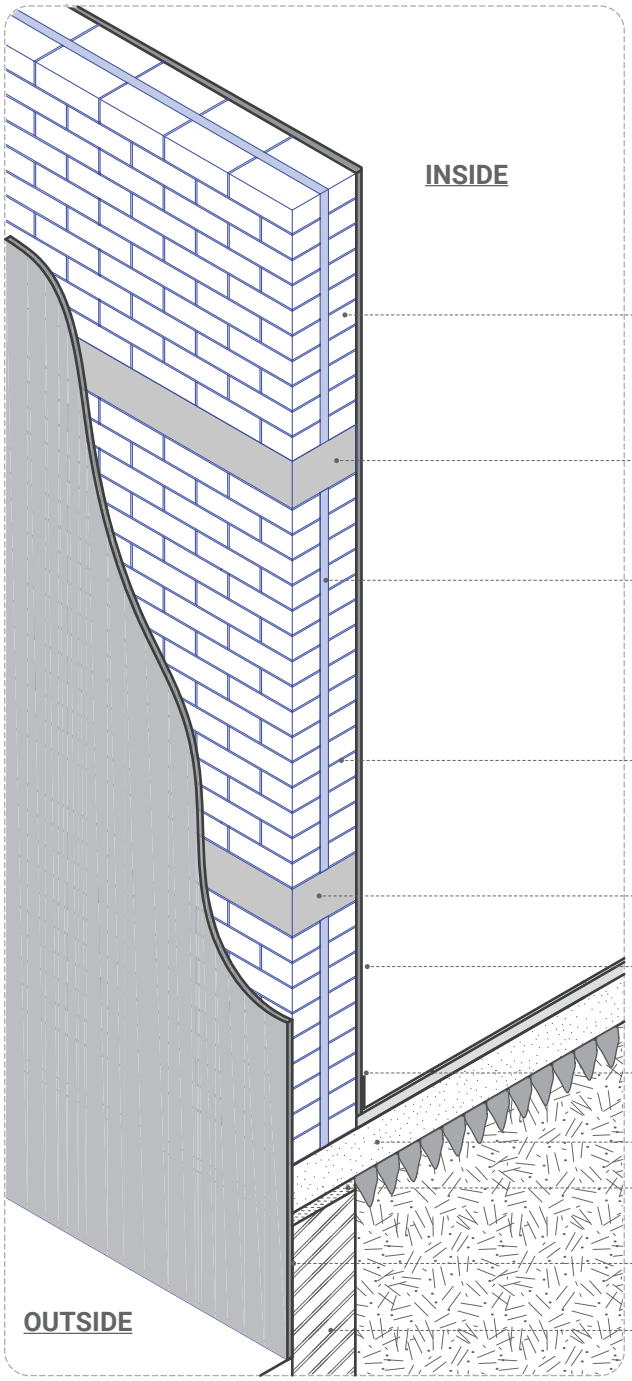
> *WALL CONSTRUCTION STRATEGIES WITH DETAILS*

Implement efficient wall for building envelope

U-value of the wall assembly shall meet the baseline of 2.5 w/m²k.T



> WALL CONSTRUCTION DETAILS



CAVITY WALL OPTIONS

100mm thk brickwork in stretcher bond on either sides of the cavity

150mm thk tie band @2100mm height

Option 1: 30mm cavity filled with EPS Thermocol (or similar)
₹₹ * Includes increased expenditure

Option 2: 30mm air cavity

5mm thk mortar

150mm thk tie band @750mm height

12mm thk internal gypsum plaster

100mm high skirting tile, material same as flooring

150mm thk pcc slab

40mm thk damp proof course

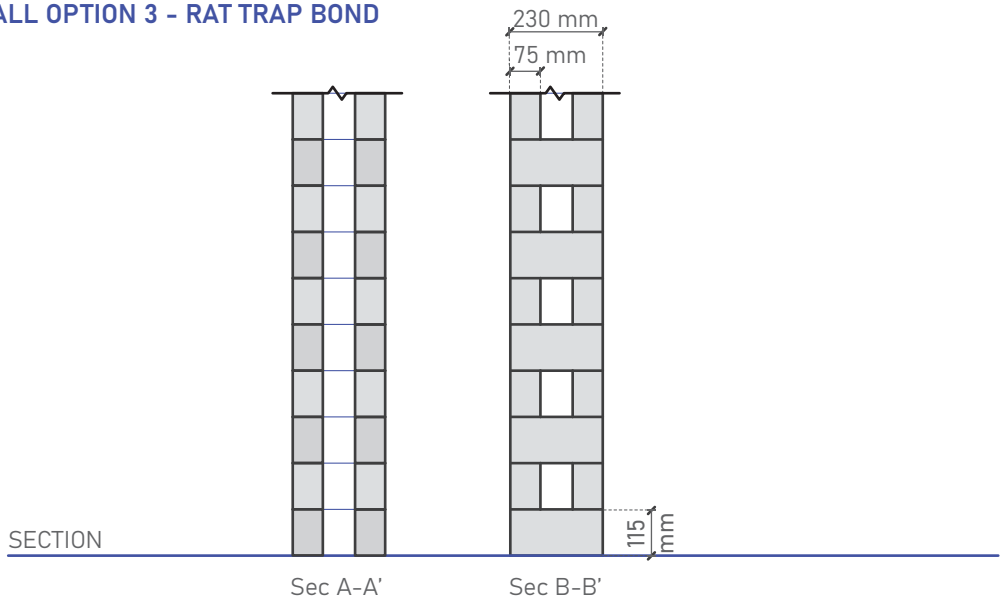
19mm thk external plaster

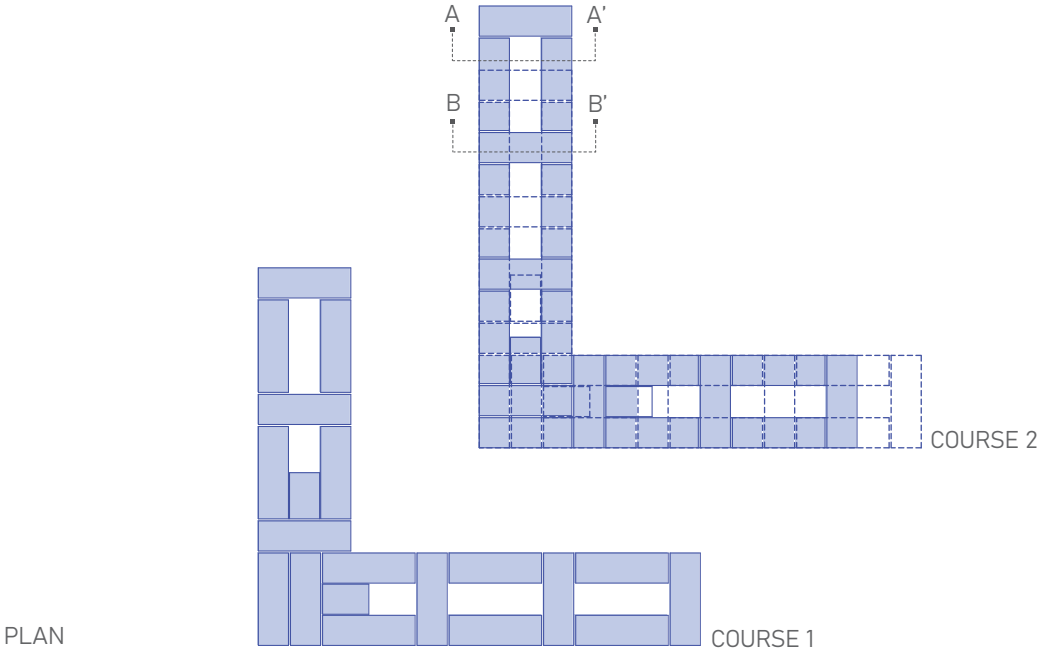
Foundation wall as per approved structural design

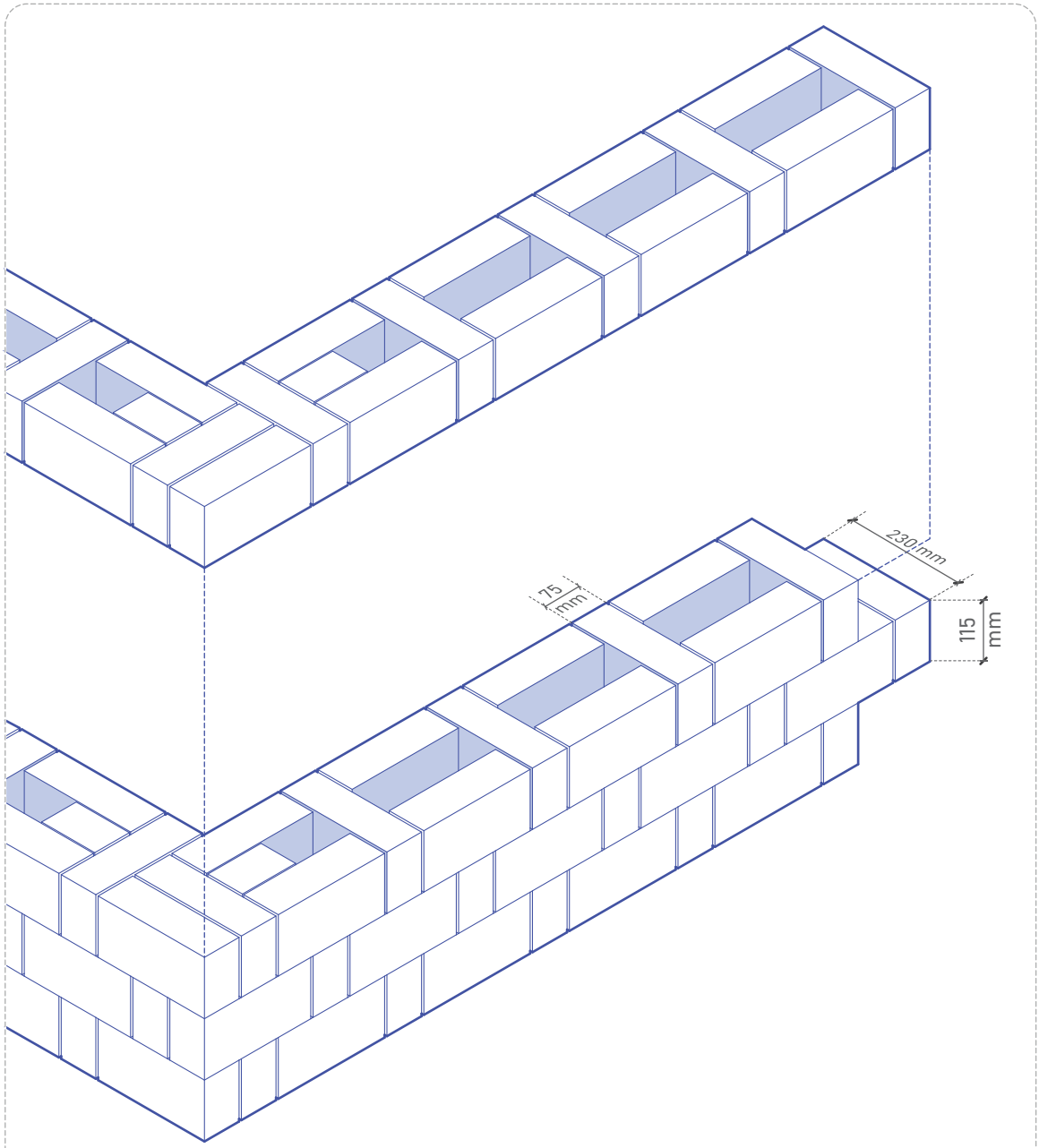
BUILDING LEVEL

> WALL CONSTRUCTION DETAILS

WALL OPTION 3 - RAT TRAP BOND



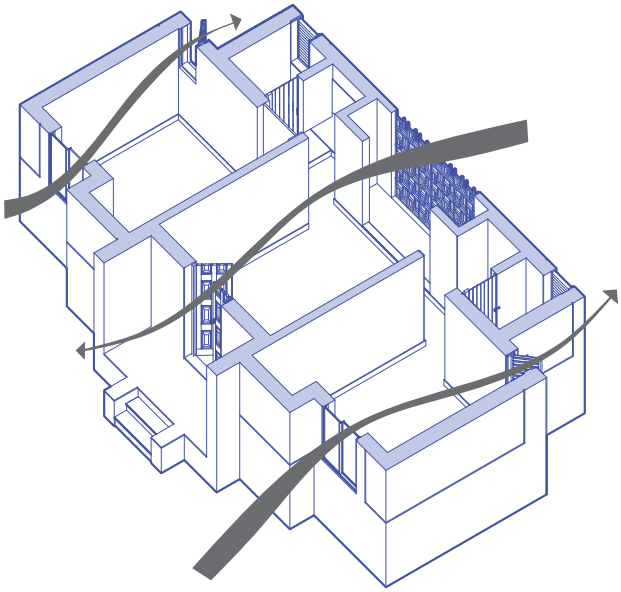


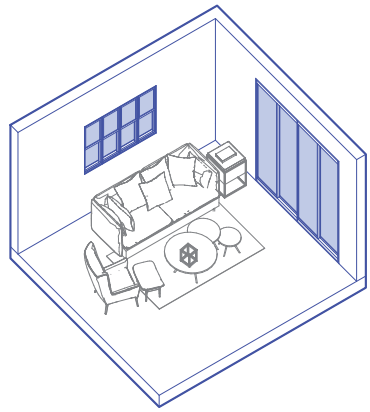


RAT TRAP BOND - EXPLODED ISOMETRIC VIEW

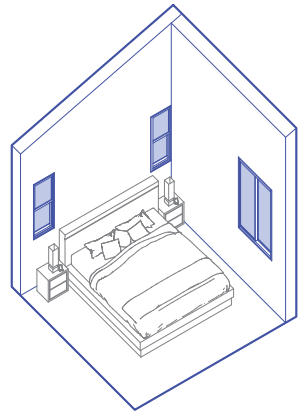
> *FENESTRATIONS WITH WWR RECOMMENDATIONS*

Window to Wall ratio (WWR) is a critical aspect of passive design strategies to achieve energy efficiency and thermal comfort.

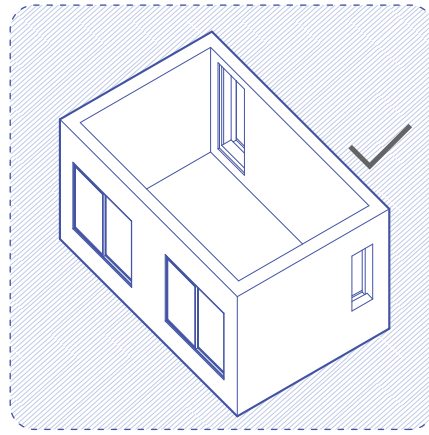


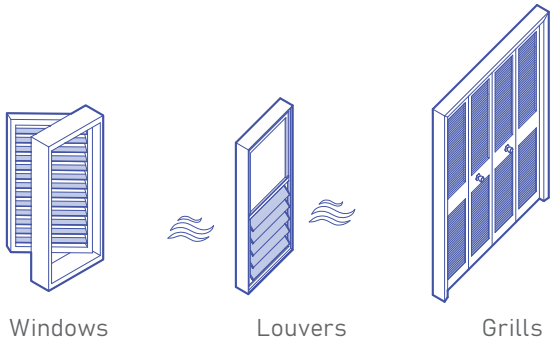


Recommended **WWR for Living Room** = 20% - 30%



Recommended **WWR for Bedoom** = 10% - 30%





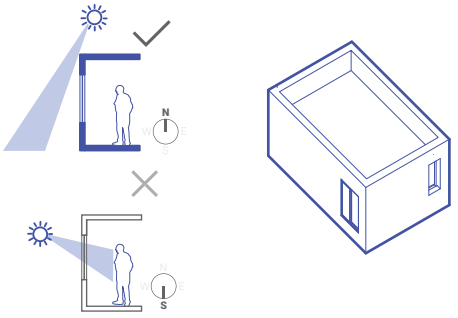
Windows Louvers Grills

For a Temperate Climatic zone, **WWR** should be **should be at least 17%. Higher percentage is better.**

HOW TO CALCULATE WWR ?

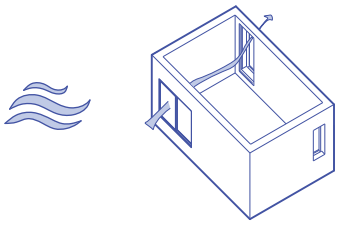
STEP 1 >>>>

Decide window placement on the building as per orientation recommendations and building structure.



STEP 2 >>>>

Decide window positions for a each room for cross ventilation to maximise natural ventilation.



STEP 3 >>>>

Determine window size on each wall as per respective recommended WWRs for your climate zone. As follows,

Wall Area(sq.ft) X WWR(%) = Area for Window(sq.ft)

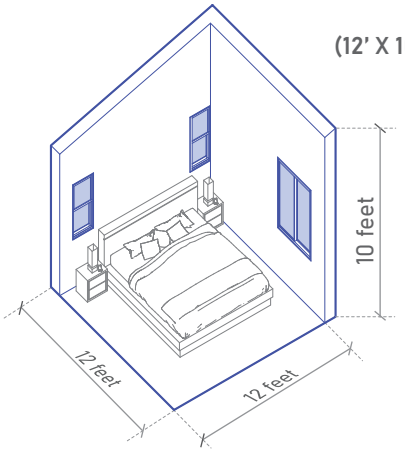
STEP 4 >>>>

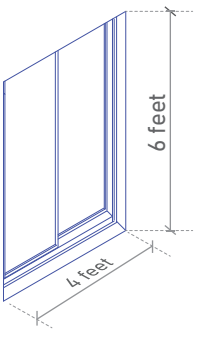
Based on the calculated area, one can decide dimensions for the window considering bedroom size, building structure and orientation

FOR EXAMPLE

20% WWR is recommended for a bedroom for your climate zone,

(12' X 10')sq.ft X 20/100 = 24 sq.ft

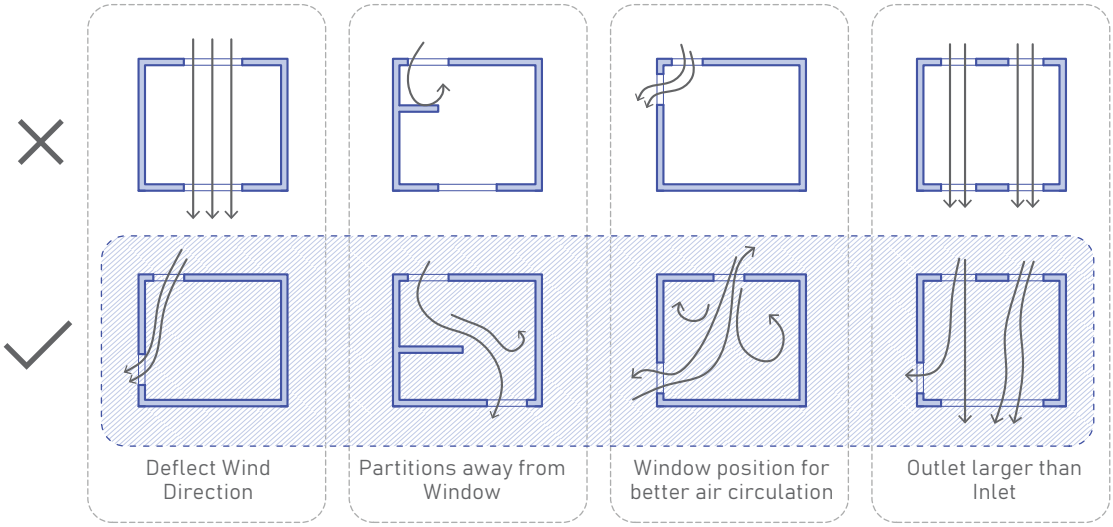




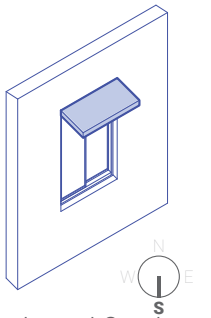
Based on the above calculated area and considering **bedroom size, building structure and orientation,** Window of size **6' x 4'** can be placed in the direction bringing least amount of glare and heat in the bedroom.

> *NATURAL VENTILATION STRATEGIES AND SHADING*

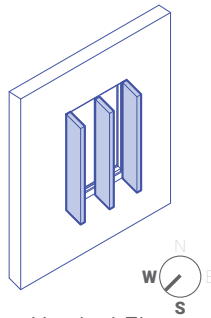
WINDOW PLACEMENTS



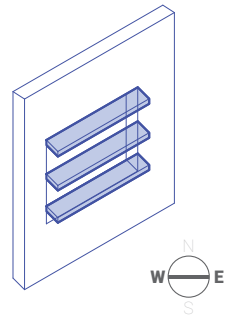
The most effective solution for shading the house is to add an external shading device such as an **overhang or a fin** that would stop the sun rays from falling onto the glass surface altogether.



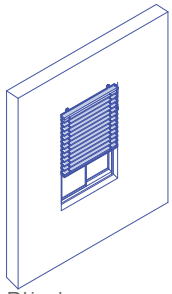
Horizontal Overhang

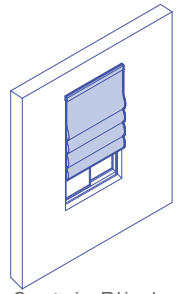


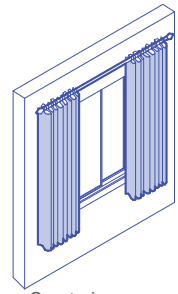
Vertical Fin



Horizontal Fin

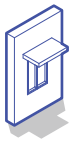
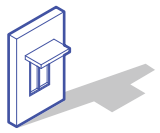
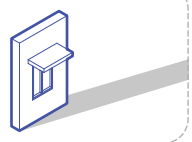
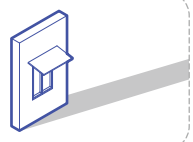
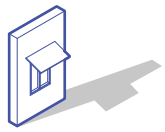
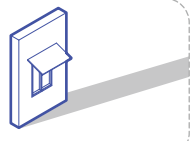

Blinds


Curtain Blinds

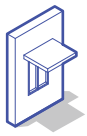
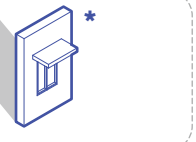
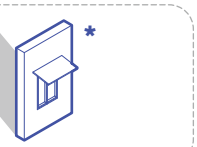
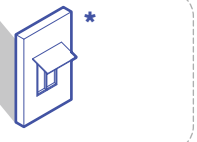

Curtains

SHADOW ANGLES

South Direction

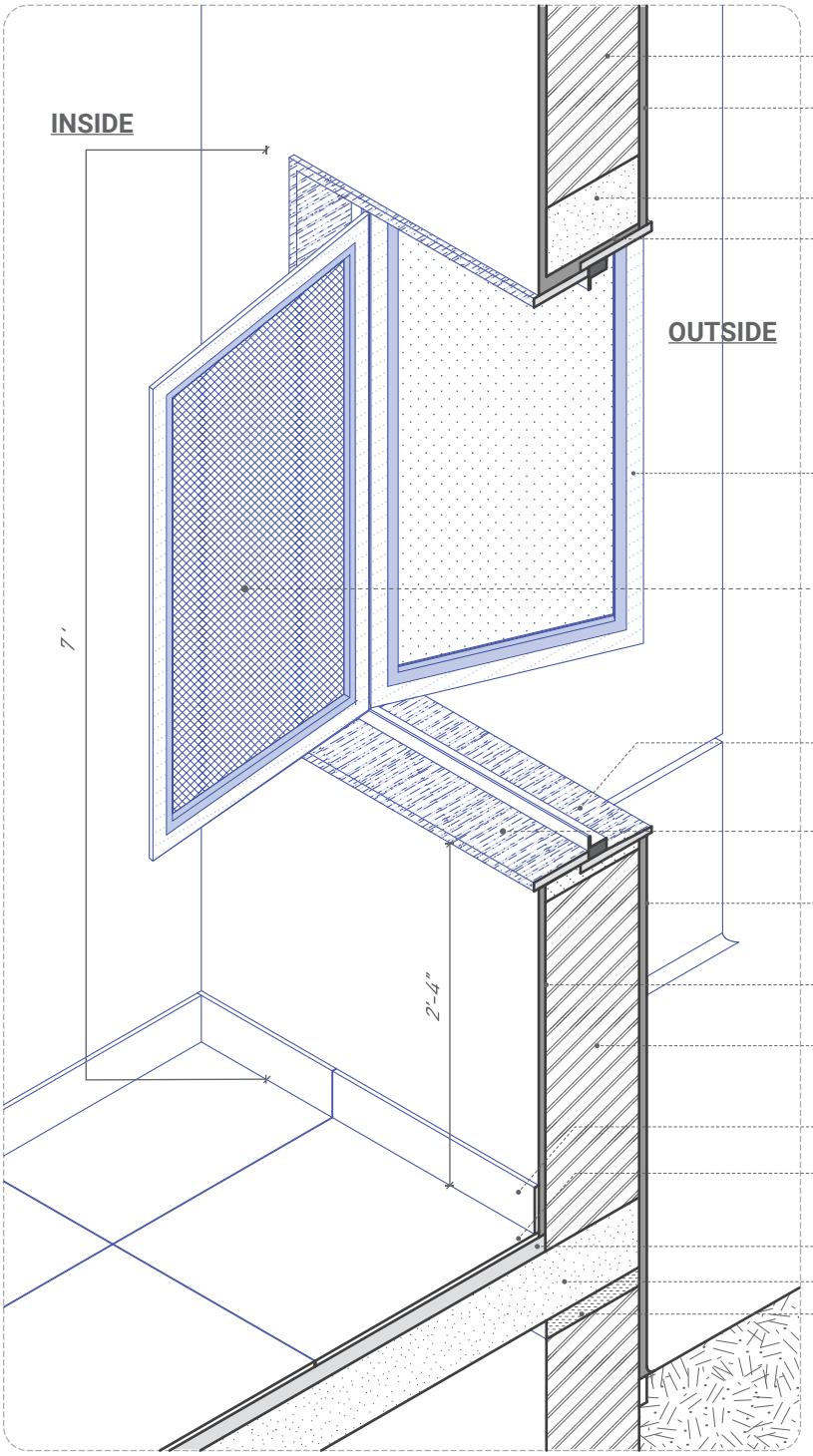
Angle	12 PM	3 PM	6 PM
0°			
10°			
20°			

West Direction

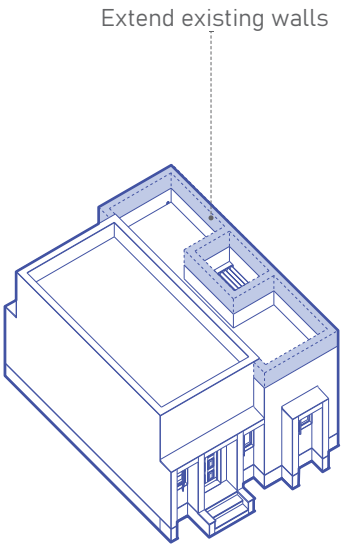
Angle	12 PM	3 PM	6 PM
0°			 *
10°			 *
20°			 *

* Due to the horizontal shading device, no/minimal shadow cast on the external wall.

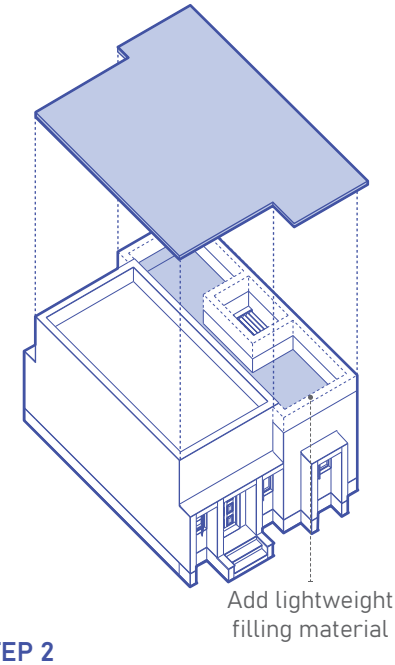
> WINDOW CONSTRUCTION DETAILS



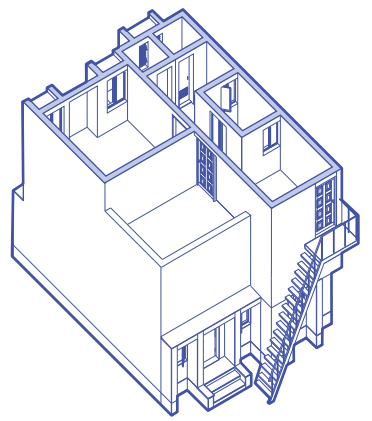
> *FUTURE EXPANSION SCENARIO*



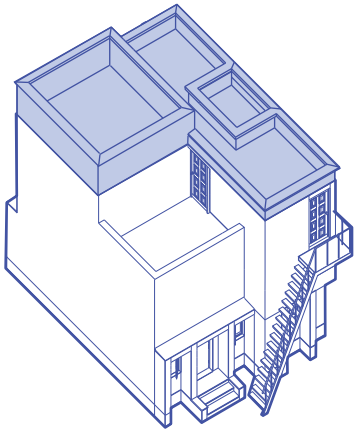
STEP 1
Extend walls of ground floor to achieve uniform height



STEP 2
Construct new slab above existing building



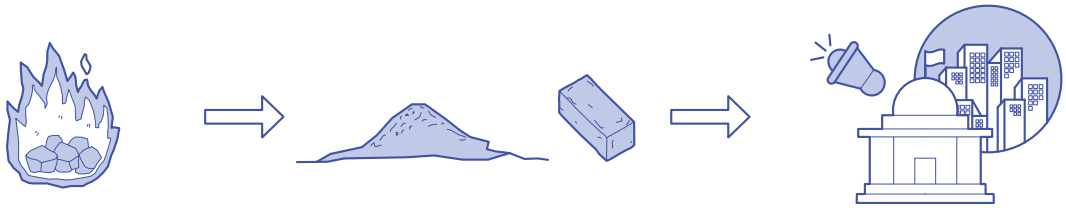
STEP 3
Construct rooms and ladder



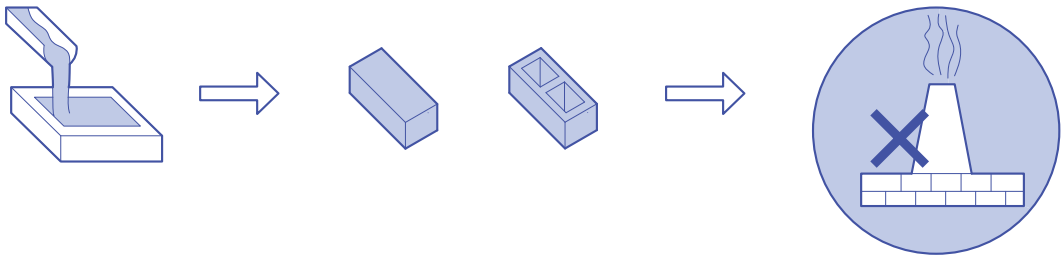
STEP 4
Add terrace slab

SUSTAINABLE MATERIAL CHOICES

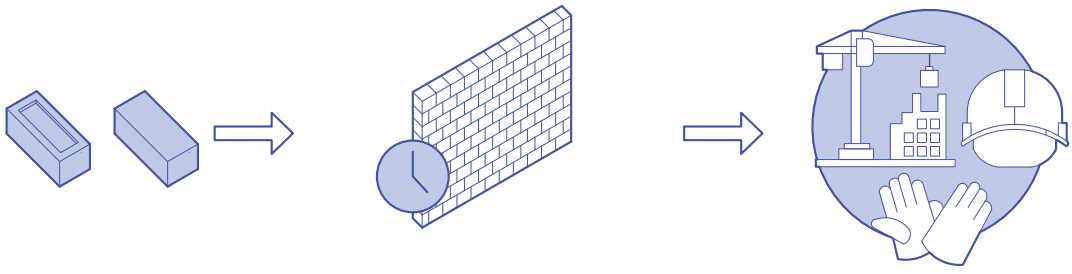
WALLING MATERIAL



The use of **fly ash** (a by-product of coal combustion) as an alternative to fired clay bricks in building construction is being promoted by the government and its availability has increased during the last two decades, particularly in the urban areas.

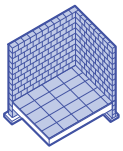
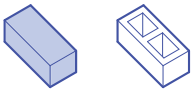
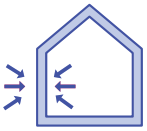
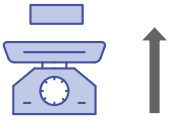
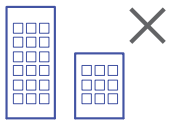


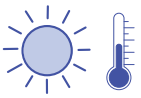
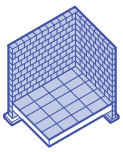
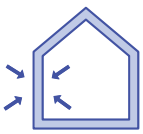
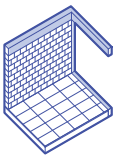
Solid concrete block and autoclaved aerated concrete **(AAC) blocks** are also widely used non-fired bricks.



The traditional red clay brick is a time-tested walling material of choice.

Centre for Advanced Research in Building Sciene and Energy (CARBSE). (November 2022). Thermal performance of Walling Materials and Wall Technology. CEPT Research and Development Foundation, CEPT University.

Types of brick	Remarks		
	PHYSICAL	THERMAL	APPLICATIONS
 Clay Fired (Extruded)	 Low water absorption	 High thermal conductivity	 Suitable for load bearing construction
 Concrete brick and block	 High compressive strength	 High thermal mass.	 High dead load  Disadvantage for mid- and high-rise buildings.
 Calcium silicate brick			

 Clay Fired (Hand Moulded)	 Medium water absorption	 Medium thermal conductivity	 Suitable for load bearing construction
 Fly ash brick	 Medium compressive strength	 Medium thermal mass.	 Suitable for Framed construction
 Compressed Stabilised Earth Blocks			
 C&D waste brick			
 Surkhi brick			

Centre for Advanced Research in Building Sciene and Energy (CARBSE). (November 2022). Thermal performance of Walling Materials and Wall Technology. CEPT Research and Development Foundation, CEPT University.

Types of brick	Remarks		
	PHYSICAL	THERMAL	APPLICATIONS
AAC blocks	High water absorption	Low thermal conductivity	Not Suitable for load bearing construction
CLC blocks	Low compressive strength	Low thermal mass.	Suitable for mid and high rise buildings
Expanded Clay Aggregate Brick			Low weight
			Savings in Construction

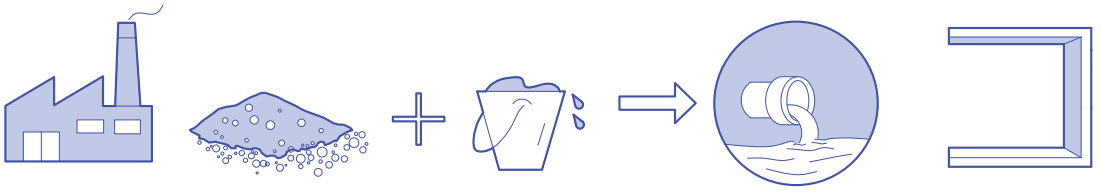
Based on above types and characteristics, below are recommendations for choosing bricks for warm and humid climate

Fly Ash Brick | Compressed Stabilized Earth Blocks | Surkhi brick | C & D waste brick | AAC blocks | CLC blocks | Clay Fired (Hand Moulded)

Most to least preferred choices

Centre for Advanced Research in Building Sciene and Energy (CARBSE). (November 2022). Thermal performance of Walling Materials and Wall Technology. CEPT Research and Development Foundation, CEPT University.

PLASTER - INTERNAL WALLS



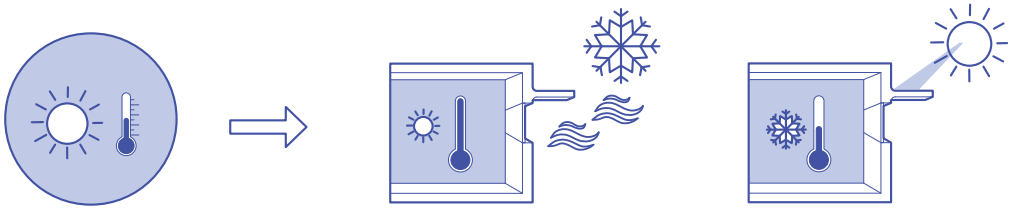
Factory made

Powdered gypsum plaster

Water

Mixed to form a ready paste

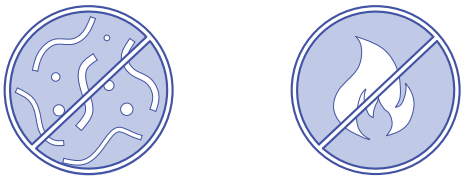
Applied on ceiling and walls



Gypsum has low thermal conductivity

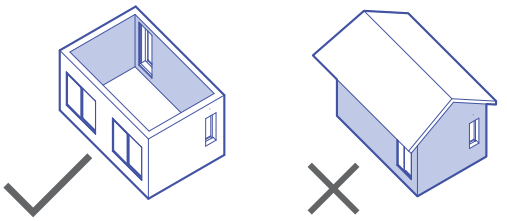
It keeps indoors warm during the cold months

Cooler during the warm summer



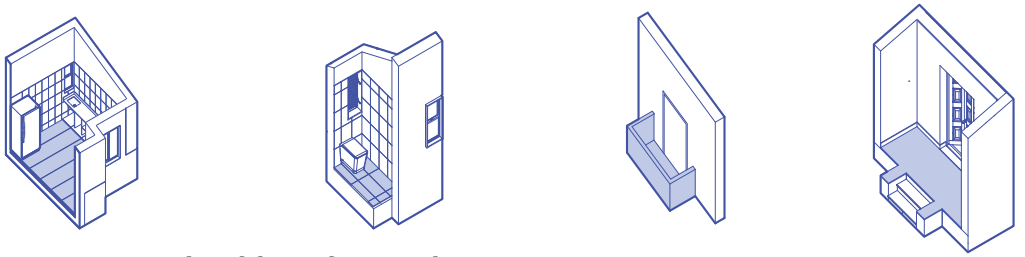
Highly resistant to mold and mildew when ventilated.

Fire resistant



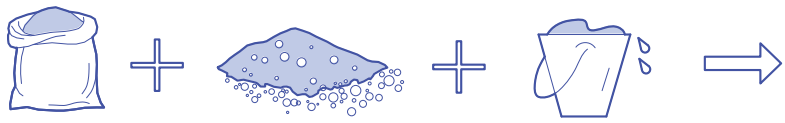
Suitable for interiors of building

Not suitable for exteriors



Gypsum plaster **should not be used** in moisture-laden areas like the bathrooms, kitchens, balconies or damp basements. Instead, **cement plaster should be used.**

PLASTER - EXTERNAL WALLS AND WET AREAS



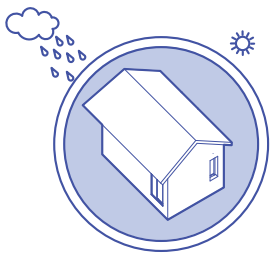
Portland cement

Sand

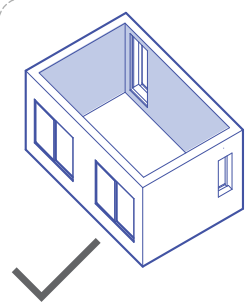
Water

Homogeneous mixture of cement plaster

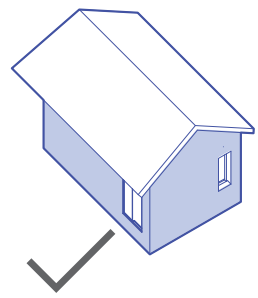
Resistant to moisture



First line of defence to protect from wind, rain, and harmful industrial gases and vehicular pollution.

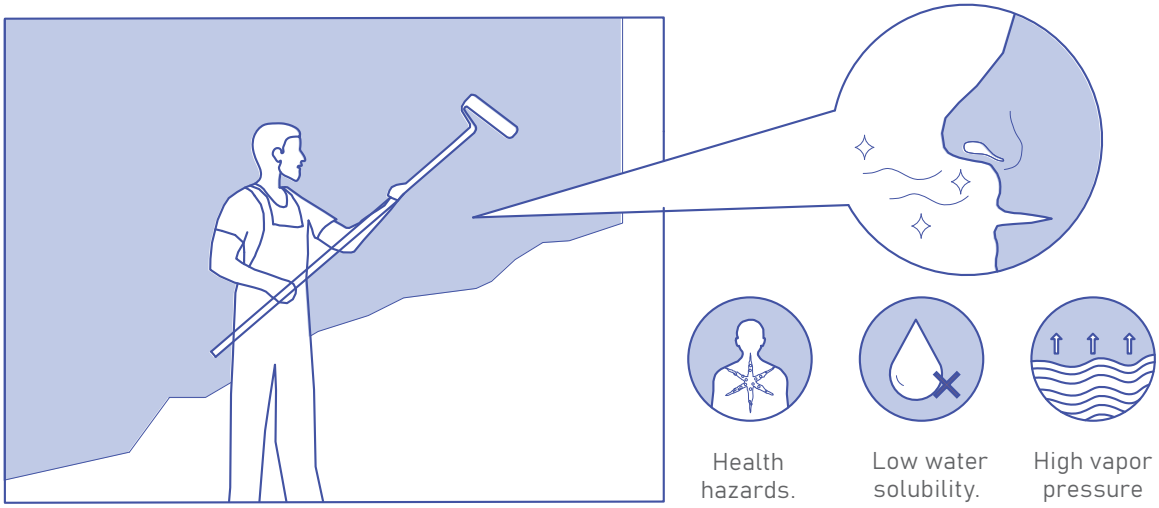


Suitable for interiors of building



Suitable for Exteriors of the building

PAINTS - INTERNAL AND EXTERNAL WALLS



Health hazards.

Low water solubility.

High vapor pressure

The **smell of freshly painted room** or surface experienced is the **result of Volatile Organic Compounds (VOCs) in paint**.

LOW VOC PAINT

VOC paint

Should not Inhale

Not good For health

Low VOC paint

Breathable

Healthy

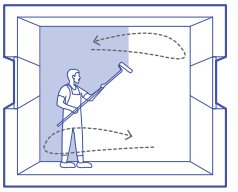
Eco friendly

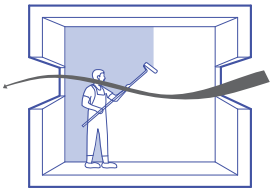
Water Based paint

Breathable

Pigments Dissolved in water

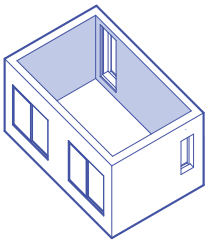
Waterbased



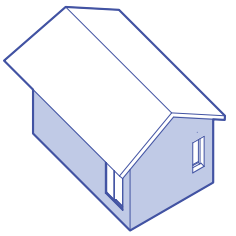


During painting, a proper circulation of fresh air while using agents that release vocs can be a great tactic to reduce the harmful effects.
One should ensure **to ventilate the rooms** well so that the vocs in paint don't continue to circulate indoors.

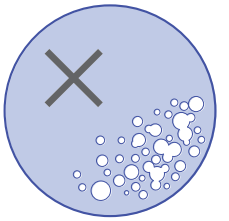
VOC of interior and exterior coating, as per GRIHA (2017) for affordable housing abridged manual.



Internal Coating



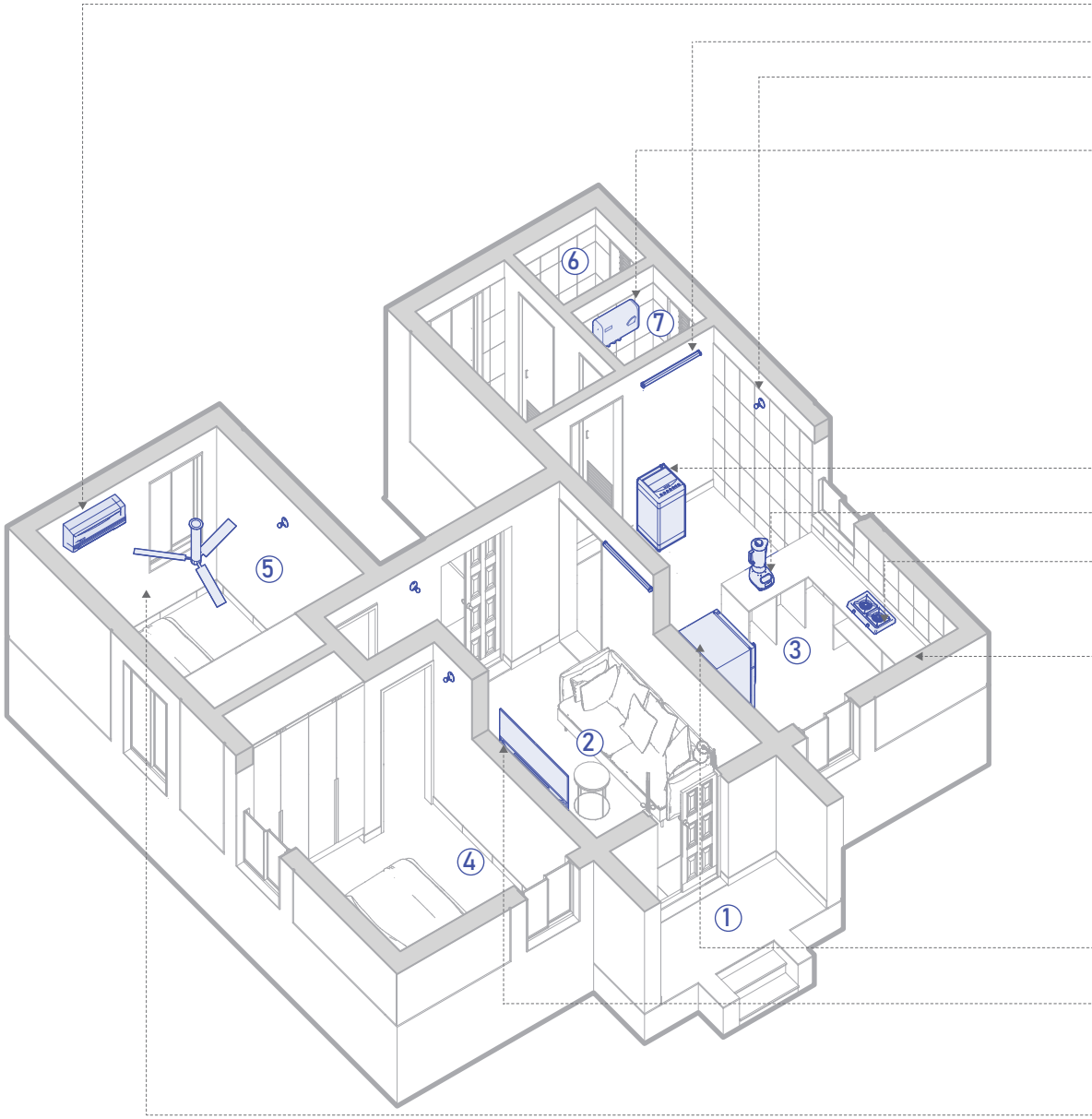
External Coating



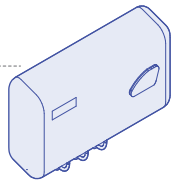
Anti Corrosive Coatings

Coating type	VOC weight in **grams/litre** of product minus water	VOC weight in **grams/litre** of product minus water	
Non Flat	< 150	< 100	
Flat	< 50	< 200	
Gloss/ Semi Gloss / Flat			< 250

SUSTAINABLE APPLIANCES AND TECHNOLOGIES

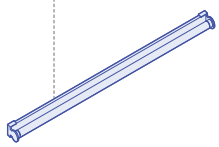


1. Verandah
2. Living Room
3. Kitchen
4. Bedroom 1
5. Bedroom 2
6. WC
7. Bath

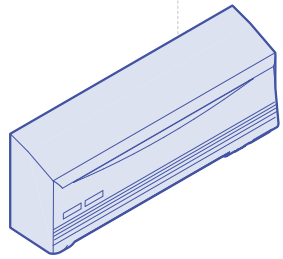


1
Gyeser

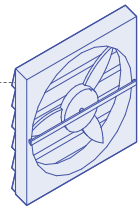
5-7
Bulbs



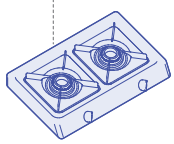
3-5
Tubelight



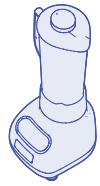
1-2
Air Conditioner



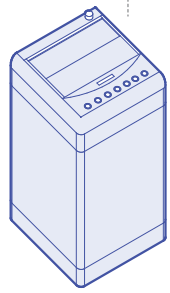
1-3
Exhaust Fan



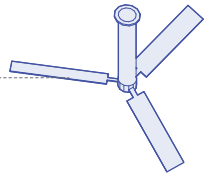
1
Gas Stove



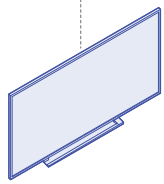
1
Mixer Grinder



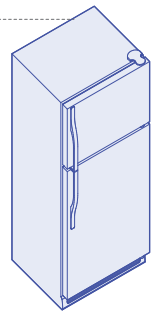
1
Washing Machine



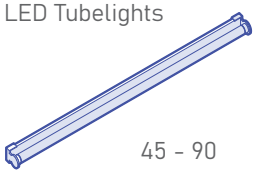
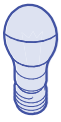
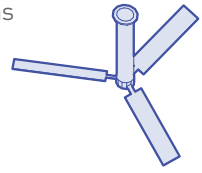
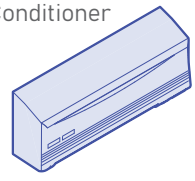
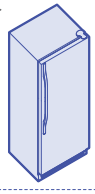
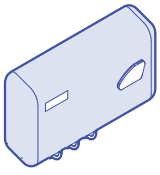
4-5
Fan



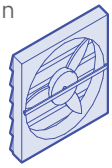
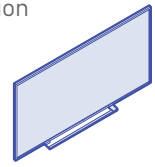
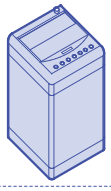
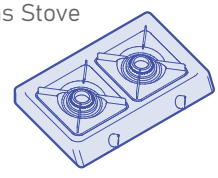
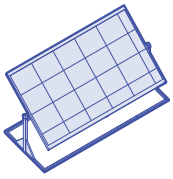
1
TV



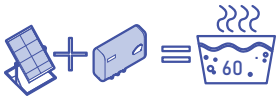
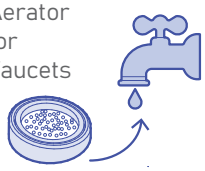
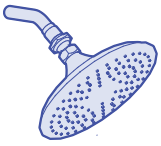
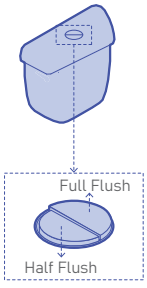
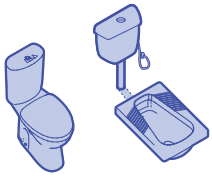
1
Refrigerator

Sr.no	Appliance/ Technology/ Systems	Watt Capacity	★ BEE Rating	₹ Cost	↑ Pros
1	**ELECTRICAL APPLIANCES**				
A	LED Tubelights  45 - 90	22 - 36	★★★☆☆	250 - 450	Reduced Wattage; Increased Life span
B	LED Bulbs 	3 - 12	★★★☆☆ ★★★★★	90 200	Reduced Wattage; Increased Life span
C	Fans 	35 - 50	★★★★★	3000 - 4000	Energy Efficient > 65 % Less Power consumption
D	Air Conditioner 	1 - 1.5 ton Split Ac	★★★☆☆ ★★★★★	31,000 36,000	Energy Efficient; Increased Life span
E	Refrigerator 	192 L to 215 L Single Door	★★★☆☆ ★★★★★	12,000 16,000	Energy Efficient; Better Cooling
F	Geyser 	15 - 25L	★★★☆☆ ★★★★★	5,700 7,000	  15 L ★★★★★ Sufficient for a family of 4

Cons	Outcome	Incrementality
Initial Cost is more	50 % Annual Savings	
Initial Cost is more	50 % Annual Savings	
Initial Cost is more	1500 Rs Per Fan	
Initial Cost is more	30 % Annual Savings	Installation Optional
Initial Cost is more	50 % Annual Savings Compared to 0 Star rating	
	40 % Annual Savings	

Sr.no	Appliance/ Technology/ Systems	WATT Capacity	★ BEE Rating	₹ Cost	↑ Pros
H	Exhaust Fan 	150 - 250	★★★☆☆ ★★★★★	600 - 1500	Energy Efficient; Better Ventilation
I	Television 	24" - 55"	★★★☆☆ ★★★★★	6000 - 55,000	Energy Efficient; Better Brightness
J	Washing Machine 	Semi Automatic 5 Kg - 7 Kg	★★★★★	9000 - 18,000	Energy Efficient; 65 % Less Power consumption
2	**LPG/PNG GAS RELATED APPLIANCES**				
A	Gas Stove 	2 - 4 Burner	★★★☆☆ ★★★★★	2000 - 3500	68 - 74% Thermal Efficiency; Better Flame
3	**SOLAR RELATED SYSTEMS**				
A	Solar Panels 	1 or more KV		30,000 - 60,000 per KV	 100 - 200 units per month

Cons	Outcome	Incrementality
Initial Cost is more	10 % Annual Savings	
Initial Cost is more	20 % Annual Savings	
Initial Cost is more	30 % Annual Savings	
Initial Cost is more	One Cylinder Per year	
Initial Cost is more	14400 Units Per year	Installation Optional

Sr.no	Appliance/ Technology/ Systems	WATT Capacity	BEE Rating	Cost	Pros
B	Solar Water Heater 	100 - 300 Litres per day		30,000 - 60,000 per KV	 Combination can supply hot water all day long
4	**SYSTEMS FOR WATER CONSERVATION**				
A	Rain Water Harvesting 			10,000 without tank	 Recharge Groundwater
B	Aerator for Faucets 	3 - 5 Litres per min		50 - 90	 Can reduce from 8 - 3 LPM
C	Low Flow Shower Heads 	6 - 8 LPM		1000 - 2500	 Water Flow from 22 - 6 LPM
D	Dual Valve Flush Tank 				

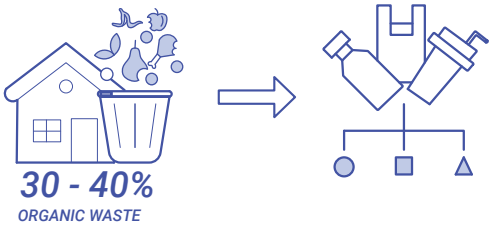
Cons	Outcome	Incrementality
Initial Cost is more	80% Savings compared to normal Gyeser	Installation Optional
	Recharge Groundwater	Installation Optional
Initial Cost is more	22,500 L Eventually saving on water bill	
	40 % Savings than regular Showerheads	

NOTE :

The above costs of the goods and systems have been defined as per the market scenario as of May 2023. It may vary over time and place.

WASTE MANAGEMENT AT HOME

1. WASTE SEGREGATION



Waste segregation at homes is one of the best methods to reduce the burden on those handling the waste.

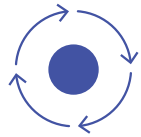
Food waste
garden waste

Glass
Paper

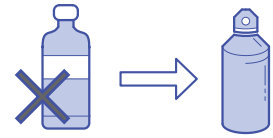
Plastic
Non-degradable
waste

2. REUSE

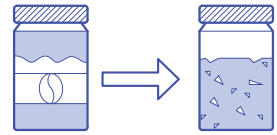
-Invest in reusable products
-Utilise products with multiple uses
-Minimise waste generation
-Keep waste away from landfills



REUSABLE
ITEMS



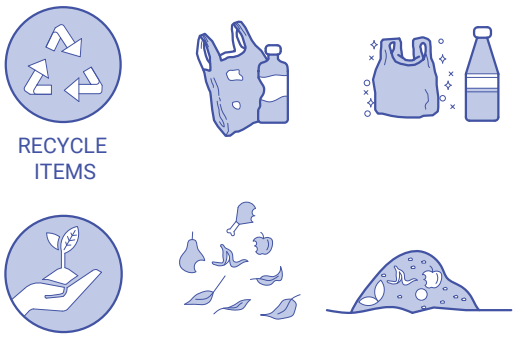
Plastic Bottle Steel Bottle



Turning coffee tins into
storage containers

3. RECYCLE

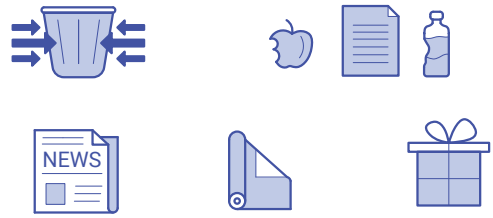
Recycling can be defined as turning any kind of waste into something new or useful.



RECYCLE
ITEMS

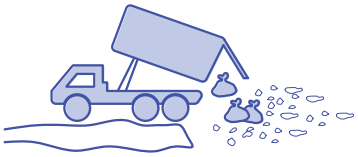
4. REDUCE

Reducing waste is more of an attitude that can be followed while dealing with food, paper and plastic.



Reusing Newspaper as wrapping paper for Gifts

5. COMPOSTING



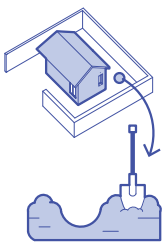
Composting is one of the best solid waste disposal methods when it comes to households, prepare the compost pile and allow the living microorganisms to break down the organic waste materials. The compost, once ready, can be used for improving soil quality and plant growth.

HOW TO START COMPOSTING?

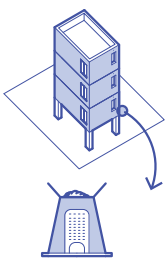
It is interesting to note that 40% – 50% of the waste produced in households is organic. Thus, composting can be done by anyone living anywhere by following the simple steps mentioned below.

STEP 1

Finding a place ???



Case 1 - open plot
To dig a pit



Case 2 - residence
Perforated bin

STEP 2

Collecting the waste

Green waste

Kitchen waste

Dried leaves

Brown waste

Saw dust

Shredded paper

Cardboard

STEP 3

Storing the waste and decomposing

Layering green and brown waste

Green waste
Adds nitrogen

Brown waste adds
Carbon rich

Browns to greens ration

STEP 4

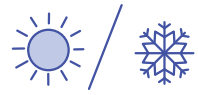
Waiting for compost to get ready

Resting for sometime

Mixing pile using stick

Optimal moisture and temperature level

Ready when smells woody and fresh



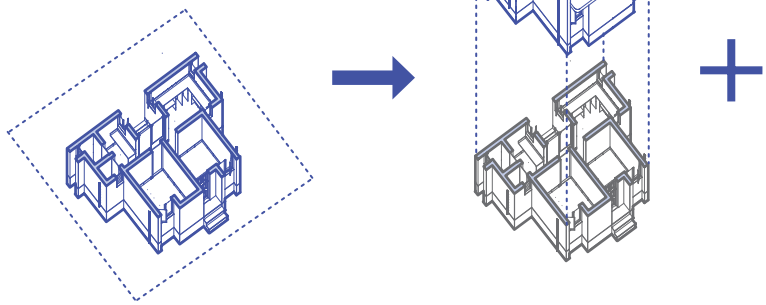
2 Months | 4 Months

ARCHITECTURAL DRAWINGS - PLANS

> *INTRODUCTION TO TYPOLOGIES*

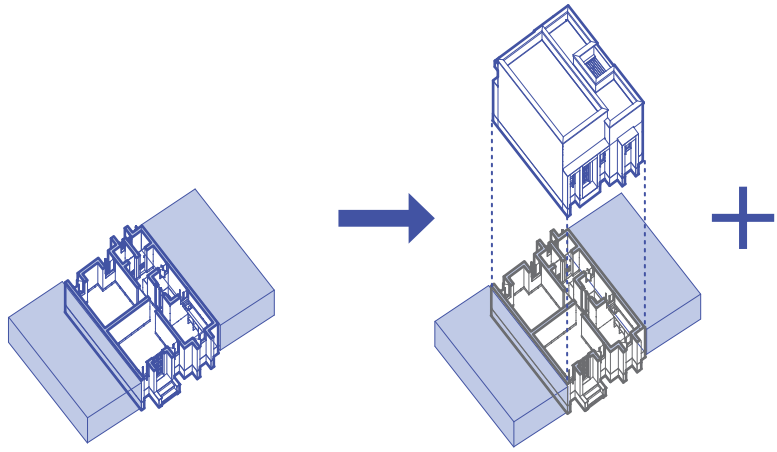
S

INDIVIDUAL HOUSE
37 SQ.M



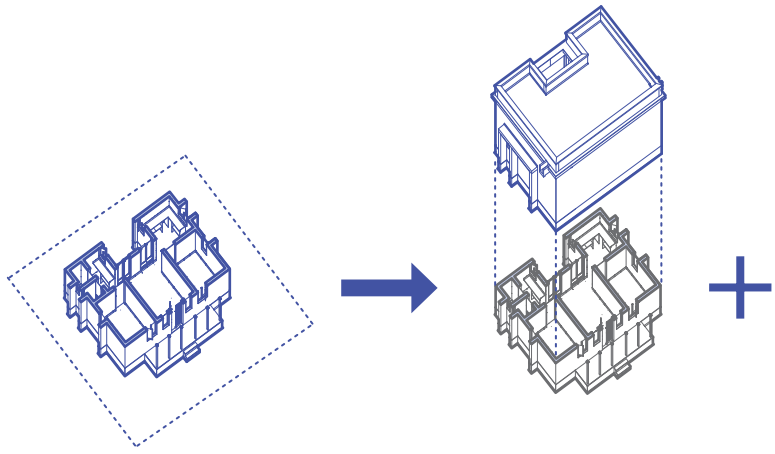
M

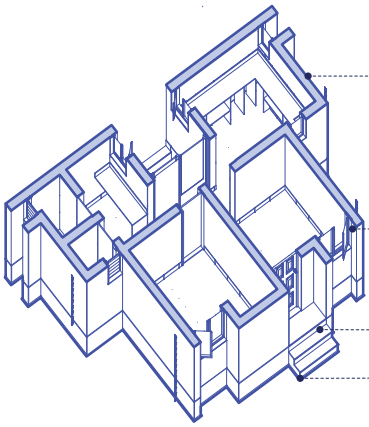
ROW HOUSE
54 SQ.M

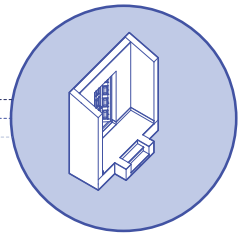


L

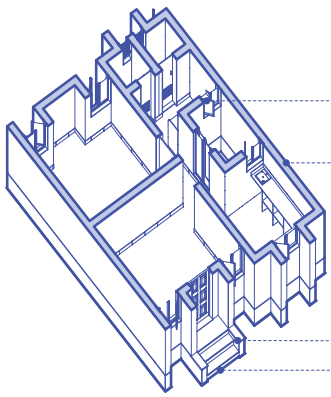
INDIVIDUAL HOUSE
60 SQ.M

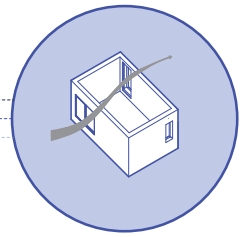




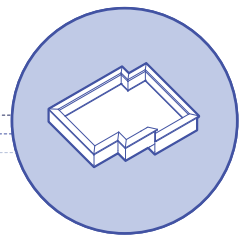


Semi open space
Verandah

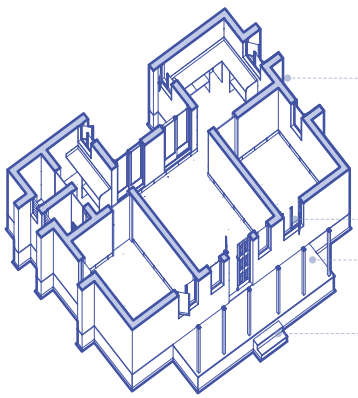


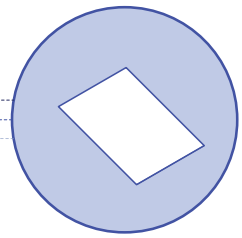


Cross - Ventilation



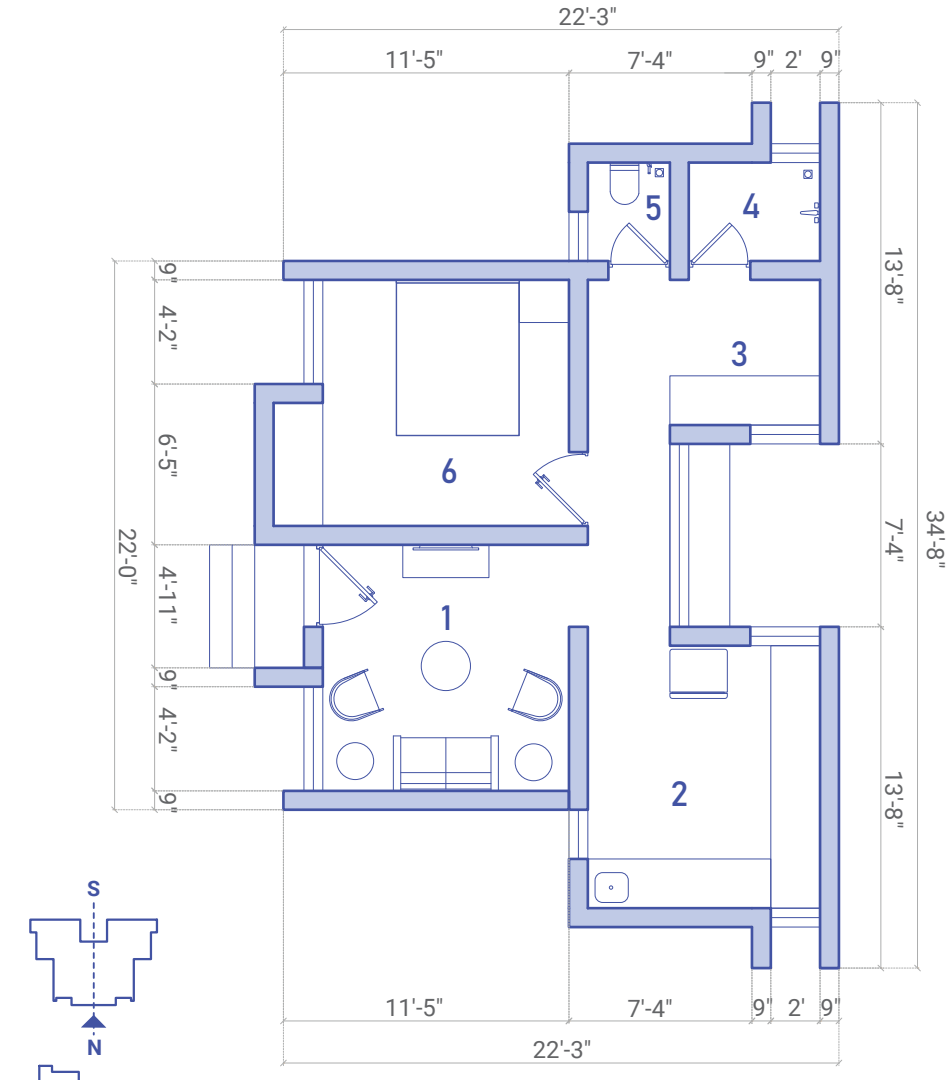
Flat Roof

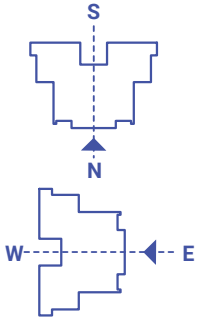




Small Footprint

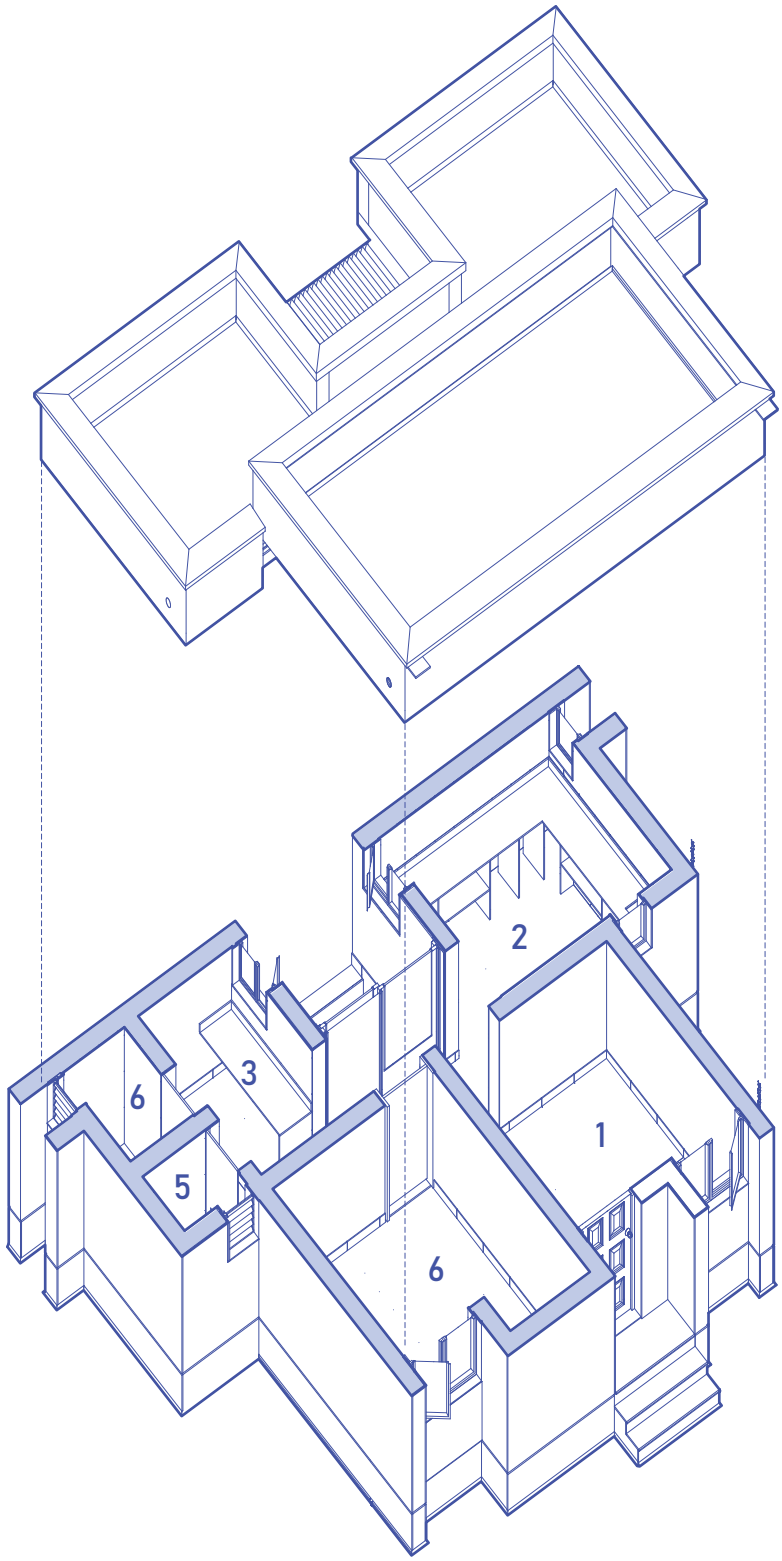
S - TYPOLOGY 1 - INDIVIDUAL HOUSE





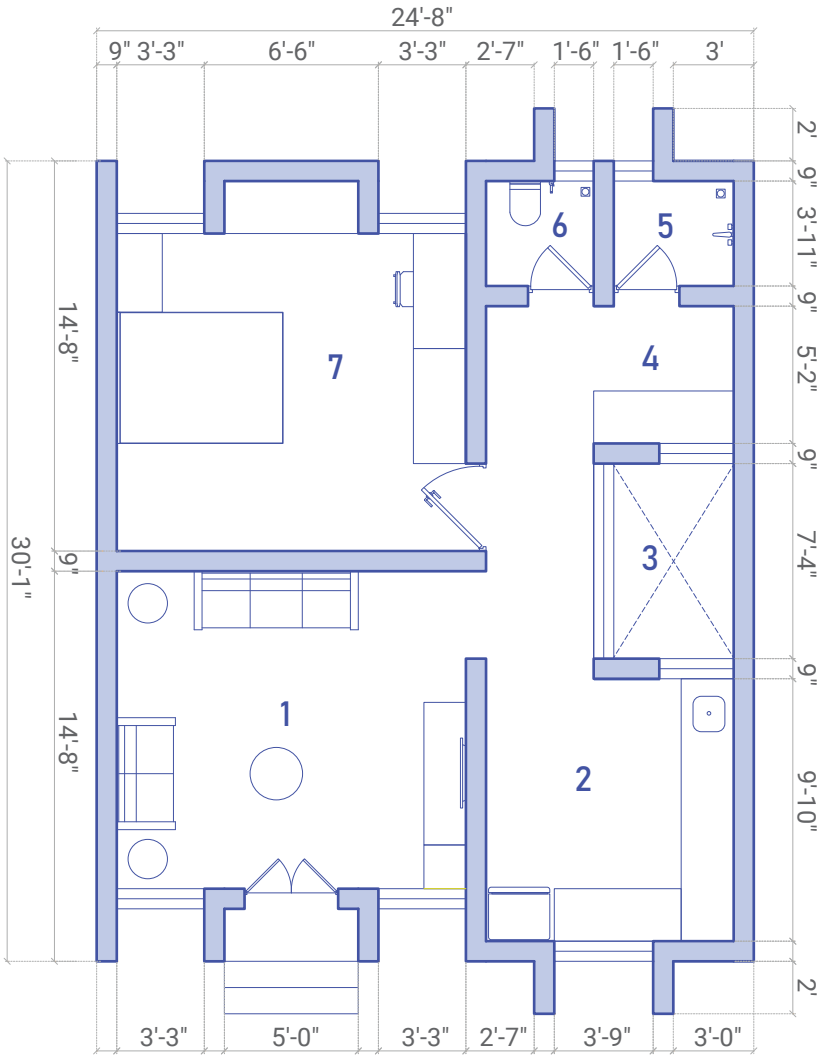
37 SQ.M

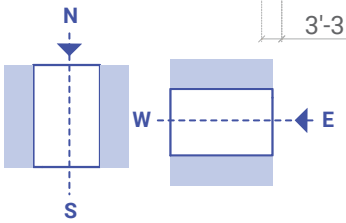
1.	Living Room	9'-10" X 9'-10"	4.	Bath	3'-11" X 5'-3"
2.	Kitchen	10'-6" X 9'-4"	5.	WC	3'-11" X 3'-3"
3.	WashBasin	5'-10" X 6'-0"	6.	Bedroom 1	9'-10" X 9'-10"

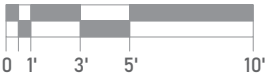


Exploded Axonometric View of the House

M - TYPOLOGY 2 - ROW HOUSE

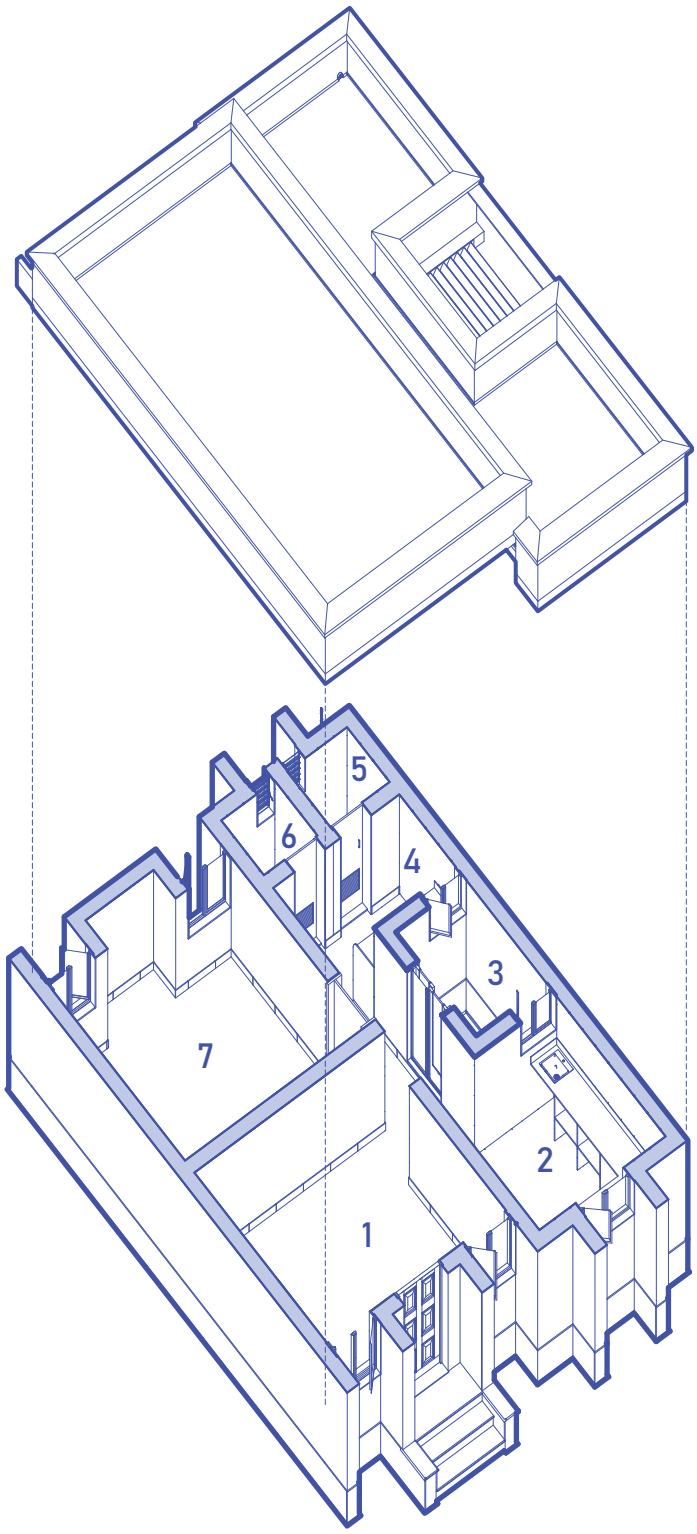






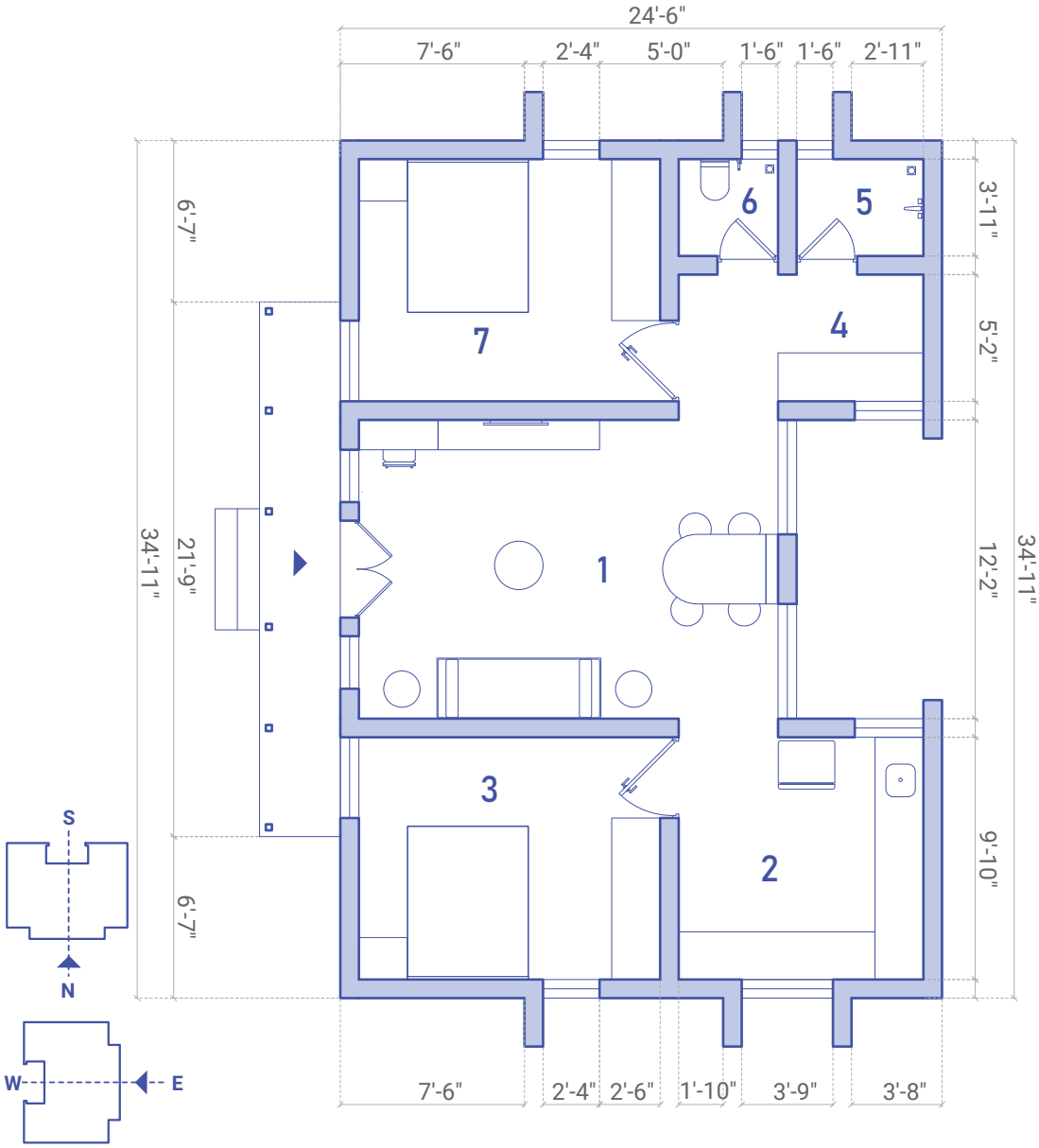
54 SQ.M

1.	Living Room	11'-11" X 13'-1"	5.	Bath	3'-11" X 4'-6"
2.	Kitchen	9'-10" X 9'-4"	6.	WC	3'-11" X 4'-0"
3.	Courtyard	7'-4" X 4'-6"	7.	Bedroom 1	11'-11" X 13'-1"
4.	WashBasin	5'-2" X 5'-3"			



Exploded Axonometric View of the House

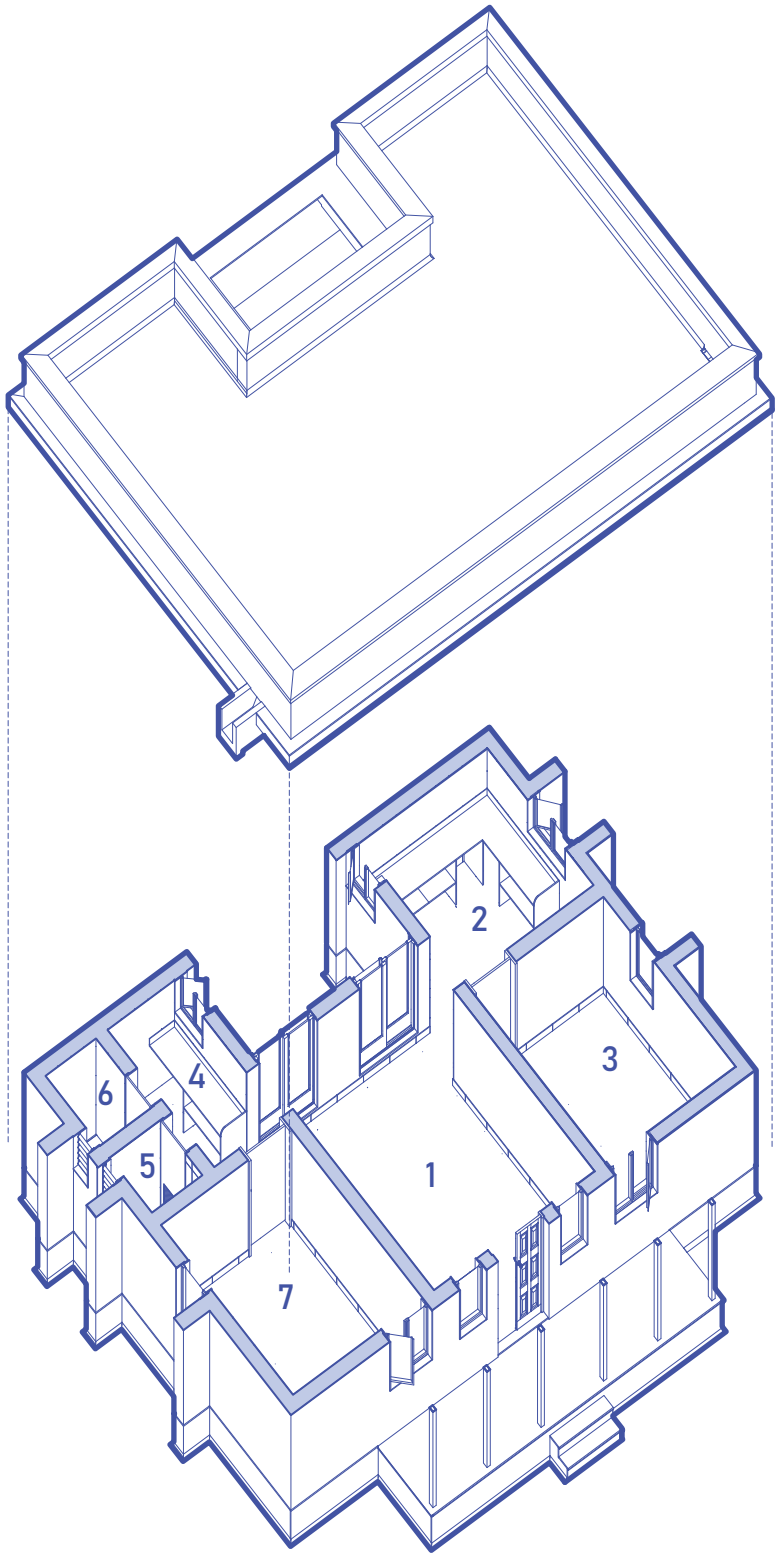
L - TYPOLOGY 3 - INDIVIDUAL HOUSE



0 1' 3' 5' 10'

60 SQ.M

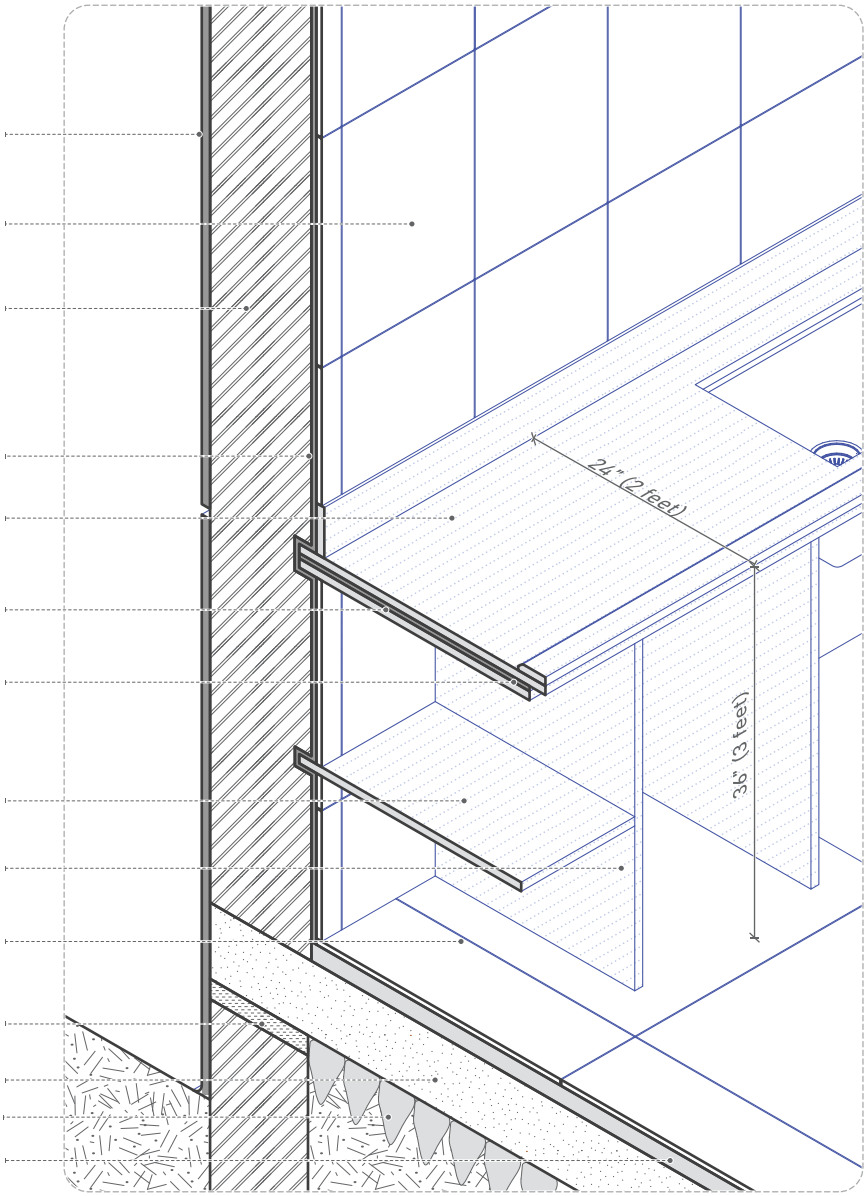
1.	Living Room	12'-2" X 17'-1"	5.	Bath	3'-11" X 5'-2"
2.	Kitchen	9'-10" X 9'-11"	6.	WC	3'-11" X 4'-0"
3.	Bedroom 1	9'-10" X 12'-3"	7.	Bedroom 2	9'-10" X 12'-3"
4.	WashBasin	5'-2" X 5'-11"			



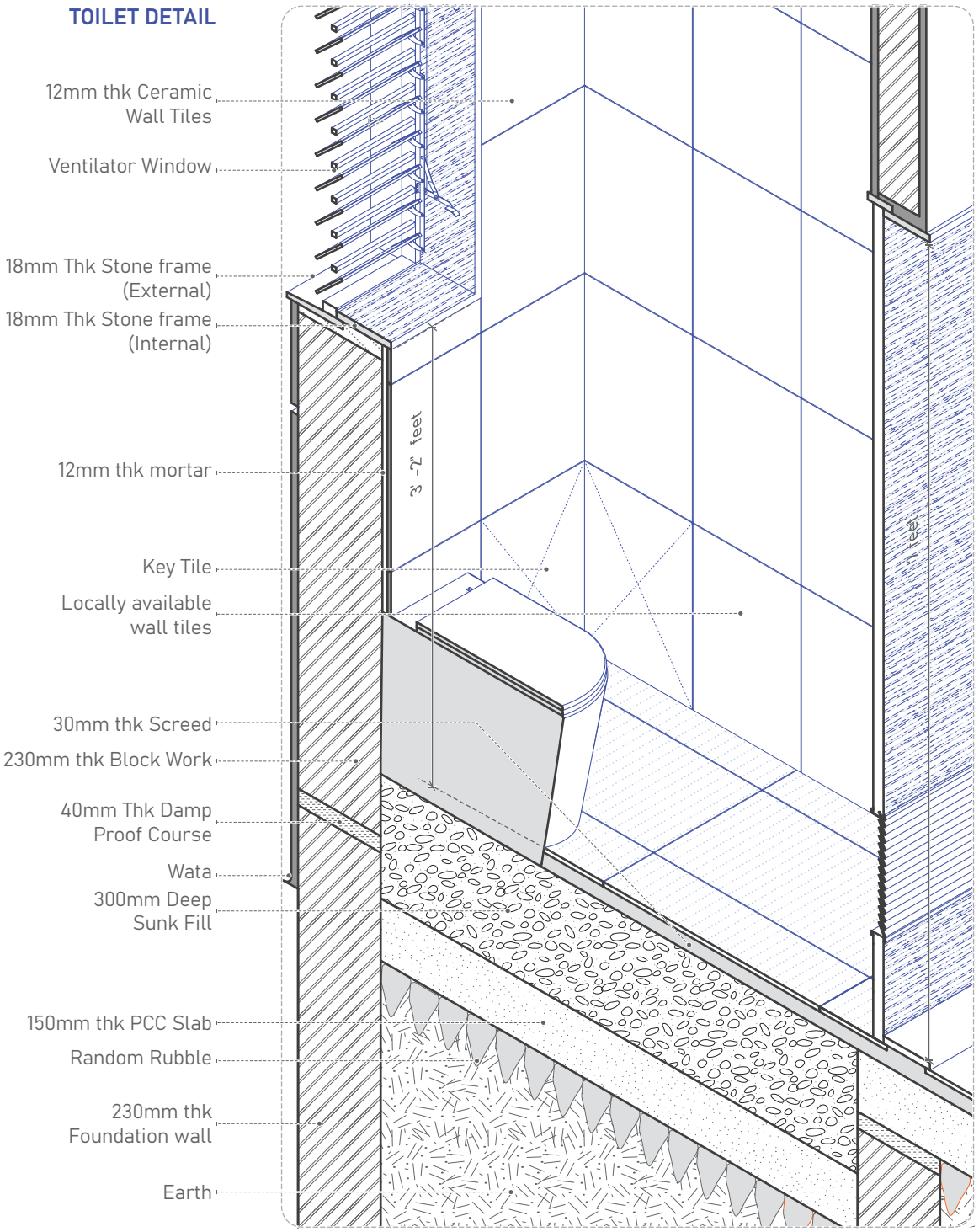
Exploded Axonometric View of the House

TYPICAL CONSTRUCTION DETAILS

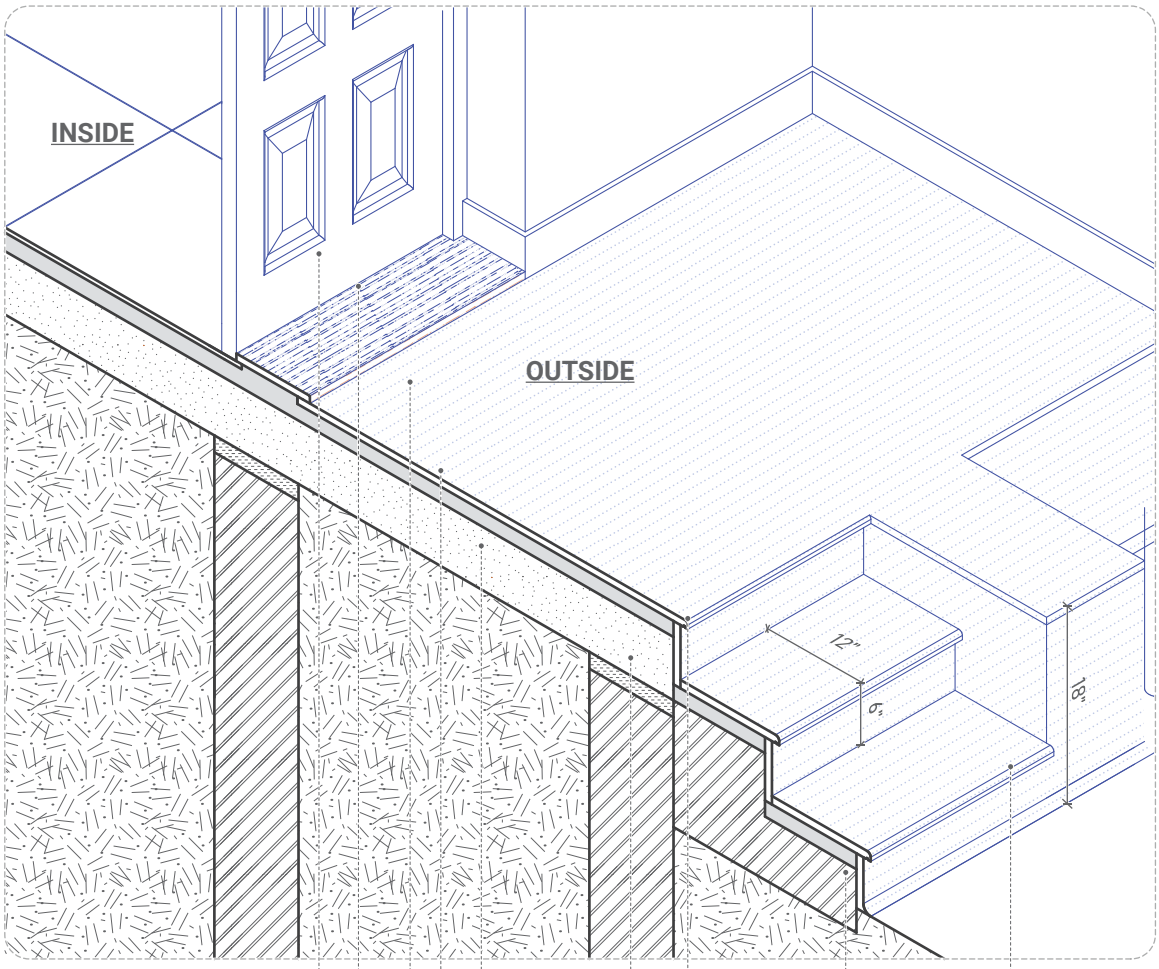
KITCHEN PLATFORM DETAIL



TOILET DETAIL



COURTYARD DETAIL



Timber Door - Double Shutter

Locally available Stone Threshold

Locally available Stone Flooring

30mm Screed

150mm Thk PCC Slab

40mm thk Damp Proof Course

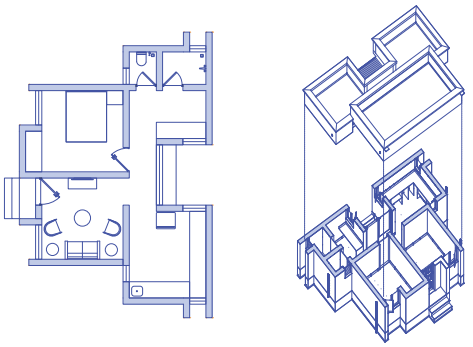
19mm thk External Plaster (Rough Cast)

Stairs in Block work

Locally available stone flooring

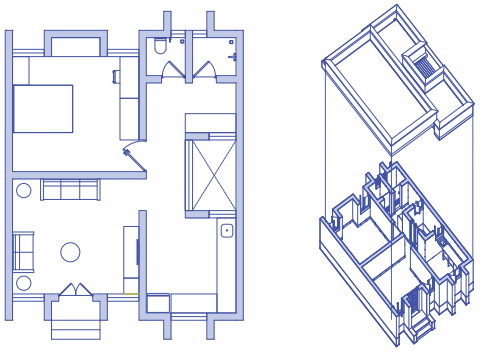
COST ESTIMATES FOR CONSTRUCTION

> *BLOCK COST ESTIMATES*



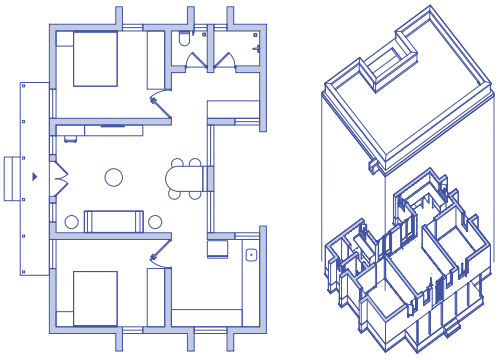
S INDIVIDUAL HOUSE
37 SQ.M

INR 10.5 to 11.5 lakhs



M ROW HOUSE
56 SQ.M

INR 13.5 to 14.5 lakhs



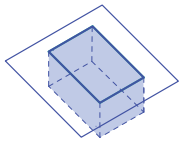
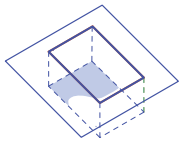
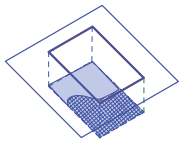
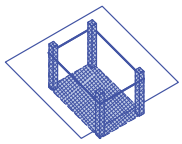
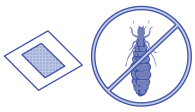
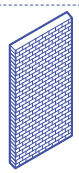
L INDIVIDUAL HOUSE
60 SQ.M

INR 16.5 to 17.5 lakhs

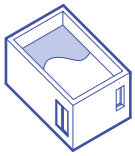
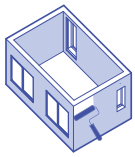
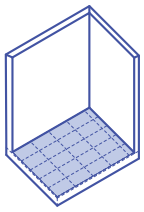
NOTE :

The above costs have been defined as per the overall construction industry scenario (costs of material, labour, etc.) in Huballi, Karnataka, as of May 2023. It may vary as per the conditions of the place of construction.

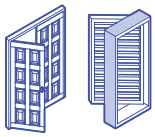
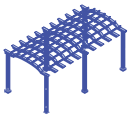
> SUMMARY: BILL OF MATERIALS

Sr. no		Item	
		ARCHITECTURAL WORKS	
1		**Earth Work Excavation**	1. Excavation: Local 2. Plinth filling 3. Rubble soling
2		**Plain Cement Concrete**	1. PCC Work
3		**Reinforced Cement Concrete**	1. RCC
4		**Steel Reinforcement**	1. Steel re-inforcement: Fe = 500 N/sq.mm
5		**Pest Control**	1. Pre-construction anti-termite treatment
6		**Masonry**	1. Full-width brick/block

Units	Individual House 37 sq.m	Row House 54 sq.m	Individual House 60 sq.m
Cum	70	73	78
Cum	40	42	48
Cum	21	22	29
Cum	19	18	21
Cum	19	19	22
MT	2	2	2
Sqm	55	71	84
Cum	62	64	69

Sr. no		Item	
		ARCHITECTURAL WORKS	
7		**Plastering**	1. External sand faced plaster
			2. Internal gypsum plaster
			3. Internal Plaster Rough
8		**Waterproofing Works**	1. Washroom water-proofing: Chemical coating with protective coat
			2. Washroom brick bat coba
			3. Terrace water-proofing chemical treatment
			4. Terrace brickbat coba + with mosaic tile finish on top
9		**Painting Work**	1. Acrylic emulsion paint
			2. Exterior grade paint
10		**Flooring, Skirting, Dado**	1. Kota flooring for varandah with entry steps tread and riser
			2. Vitrified tile floor
			3. Vitrified tile dado
			4. Vitrified tile skirting
			5. Window frame in granite
			6. Threshold in granite
			7. Twin granite slab frame
			8. Granite pantry counter
			9. Granite hand wash counter

Units	Individual House 37 sq.m	Row House 54 sq.m	Individual House 60 sq.m
Sqm	177	193	191
Sqm	123	156	167
Sqm	28	27	31
Sqm	14	14	15
Cum	1	1	1
Sqm	54	56	84
Sqm	54	56	84
Sqm	182	215	252
Sqm	177	193	191
Sqm	3	2	10
Sqm	44	56	71
Sqm	29	27	32
Rmt	44	70	66
Rmt	48	46	67
Rmt	2	2	2
Rmt	10	10	10
Rmt	6	5	6
Rmt	2	2	2

Sr. no		Item	
		ARCHITECTURAL WORKS	
11		**Doors and Windows**	1. Main entry door : 1000mm X 2100mm (single shutter) 2. Bedroom door : 1000mm X 2100mm (single shutter) 3. Washroom door : 750mm X 2100mm (single shutter) 4. Courtyard entry door : 2200mm X 2100mm 5. Aluminium windows 6. Louvered windows (powder coated)
12		**Plumbing Work**	1. Plumbing works for kitchen 2. Plumbing works for WC and shower 3. PVC nahni traps 4. Kitchen sink with tap, stop cock, bottle trap, waste coupling 5. EWC with concealed flush valve, stop cock, health faucet and bib cock 6. Washbasin with tap, stop cock, bottle trap, waste coupling 7. Shower unit
13		**Miscellaneous Work**	1. Metal pergola
14		**Electrical Work**	1. Electrical wiring & cabling, switch & sockets, lightfixtures, fan etc

EXCLUSIONS

- Interior work including carpentry furniture, loose furniture, wall panelling, false ceiling work
- Artwork and artefacts
- External electrical and irrigation work
- Landscape work, septic tank, compound wall

Units	Individual House 37 sq.m	Row House 54 sq.m	Individual House 60 sq.m
Nos	1	1	1
Nos	1	1	2
Nos	2	2	2
Nos	1	1	2
Sqm	7	17	10
Sqm	2	2	2
Nos	1	1	1
Nos	2	2	2
Nos	3	3	3
Nos	1	1	1
Sqm	1	1	1
Sqm	1	0	1
Sqm	1	1	1
Sqm	4	4	8
LS	1	1	1

NOTE :

For costing estimates on white goods, light, fan, etc., refer to the section 'Sustainable Appliances and Technologies' (pages 33-38).

REFERENCES

Alpha Pro | Solar Domestic Water Heater in India. (n.d.). Racold. Retrieved February 23, 2023, from https://www.racold.com/solar-water-heaters/alpha-pro

Bharat Hi-Star® Stove. (n.d.). Bharat Petroleum. Retrieved February 23, 2023, from https://www.bharatpetroleum.in/R-and-D-Centre/Hi-Star-Stove.aspx

Center for Advanced Research in Building Science and Energy (CARBSE). (2022, September). Climate Smart Buildings Handbook [Training Program on Innovative Construction Technologies & Thermal Comfort in Affordable Housing]. CEPT Research and Development Foundation (CRDF).

Centre for Advanced Research in Building Sciene and Energy (CARBSE). (November 2022). Thermal performance of Walling Materials and Wall Technology. CEPT Research and Development Foundation, CEPT University.

CEPT Research and Development Foundation (CRDF). (2022, October). Climate Smart Buildings Training Program on Innovative Construction Technologies & Thermal Comfort in Affordable Housing HANDBOOK.

Chandra, N. (2023, February 14). How much does Solar Panel Installation Cost in India, 2023. Loom Solar's. Retrieved February 23, 2023, from https://www.loomsolar.com/blogs/collections/solar-panel-installation-cost-in-india

Difference Between 3 Star and 5 Star AC. (2022, March 8). Everything Better. Retrieved February 23, 2023, from https://www.everythingbetter.in/difference-between-3-star-and-5-star-ac/

ECO-NIWAS. (n.d.). ECO-NIWAS. Retrieved January 6, 2023, from https://www.econiwas.com/energy-efficiency-in-buildings.html#head3

Eco-niwas Samhita 2018 (Energy Conservation Building Code for Residential Buildings) (Vol. Part i: Building envelope). (2018). Bureau of Energy Efficiency.

Fairconditioning. (n.d.). Window Shape and Sizing - Fairconditioning. https://fairconditioning.org/knowledge/passive-design/window-shape-and-sizing/#1500296799565-408a1441-895b

Gangwar, G., Kaur, P., & Singh, I. (2020, December 6). A Study of Passive and Active Strategies through Case Studies for the Composite Climate Zone of India. Civil Engineering and Architecture, -(-), -.

Gov. of India. (2021, 2021). Pradhan Mantri Awas Yojana (Urban)_Housing for All Mission_Scheme Guidelines. Ministry of Housing & Urban Affairs Government of India.

GRIHA. (2017). GRIHA for Affordable Housing Abridged Manual (Volume 1). GRIHA Council.

Han, E. (2022, September 13). What Is Impact Measurement? | HBS Online. HBS Online. Retrieved February 21, 2023, from https://online.hbs.edu/blog/post/what-is-impact-measurement

Handbook of Replicable Designs for Energy Efficient Residential Buildings. (2021, July). Bureau of Energy Efficiency, Ministry of Power, Gov. of India.

Houzz. (2018, December 16). Cement Plaster vs Gypsum Plaster. Retrieved Feb 7, 2023, from https://www.houzz.in/magazine/cement-plaster-vs-gypsum-plaster-stsetivw-vs~116271903

IGBC Rating System for Green Affordable Housing (Pilot Version). (2017, May). Indian Green Building Council (IGBC).

IGBC's NEST Ecofriendly Self-developed Tenements. (2022, October). Indian Green Building Council (IGBC).

Kapoor, V. (2023, January 11). Impact of LED lighting on power consumption in India: Opportunities and challenges - ET EnergyWorld. ETEnergyworld.com. Retrieved February 23, 2023, from https://energy.economictimes.indiatimes.com/news/power/impact-of-led-lighting-on-power-consumption-in-india-opportunities-and-challenges/96904791

Koopman, A. (2021, July 27). How to grow your own herb garden in any indoor or outdoor space. SFGATE. Retrieved January 12, 2023, from https://homeguides.sfgate.com/grow-herb-garden-indoor-outdoor-13771633.html

Ministry of Power. (2023, January 5). UJALA – UNNAT JYOTI BY AFFORDABLE LEDS FOR ALL 72.18 LAKH TUBELIGHTS 23.59 LAKH FANS 36.86 CRORE LEDS. Retrieved February 23, 2023, from https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/jan/doc2023112151401.pdf

National Policy Roadmap for Home Automation Technologies for Residential Energy Efficiency. (2021, July). Bureau of Energy Efficiency, Ministry of Power, Govt. of India.

Sathyabama Institute of Science and Technology. (-). Design with Climate. In Design with Climate (-). School of Building and Environment_Department of Architecture.

What is the difference between BLDC Fans and Normal Fans. (2022, June 14). Crompton. Retrieved February 23, 2023, from https://www.crompton.co.in/blogs/fans/bldc-fan-vs-normal-fan/

What is VOC? | Zero VOC Paints – Kansai Nerolac. (n.d.). Nerolac. Retrieved February 7, 2023, from https://www.nerolac.com/healthy-home-paints/what-is-voc.html

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