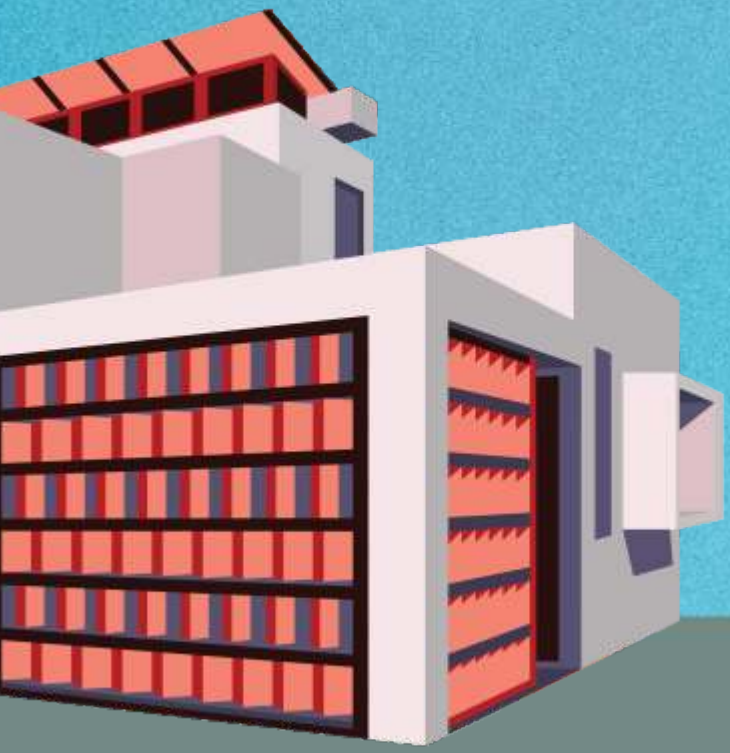
IIFL Home Finance Ltd.
India's Leading Affordable Housing Finance Company

IIFL HOME LOAN

Building Homes for Tomorrow

Supporting 'Housing for All'

Journey from Self-Construction to Green Certification



IIFL HOME FINANCE'S GUIDE TO SUSTAINABLE AFFORDABLE HOUSING

V2.0

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CONCEPT AND CURATION

IIFL Home Finance Ltd.
Monu Ratra

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We extend our heartfelt gratitude to **Mr. Monu Ratra, ED & CEO of IIFL Home Finance Limited (IIFL HFL)**, for his unwavering support and leadership in advancing the cause of sustainable and affordable housing. His vision and commitment to green building practices have been a guiding force behind this initiative.

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To everyone who has contributed directly or indirectly to this handbook, we express our sincere thanks. Your collective efforts have helped create a resource that we hope will inspire, educate, and empower individuals and communities to embrace green, sustainable, and affordable housing practices.

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THE NEED FOR SUSTAINABLE HOUSING

India is confronting the escalating impacts of climate change, with rising temperatures and increasingly frequent extreme heat events becoming a harsh reality. Heatwave occurrences have significantly risen, affecting 9 states in 2015 and expanding to 23 states by 2020 (National Disaster Management Authority). In 2024, 37 cities across the subcontinent experienced temperatures exceeding 45°C. As urbanization continues, many cities are turning into "heat islands," where dense construction and limited green spaces intensify the heat, reducing livability. This highlights an urgent need to rethink the urban planning and construction, with sustainable design and climate-resilient building methods offering a path to mitigate the effects of extreme heat, especially as cities expand at unprecedented rates.

Energy security is another critical concern, as climate-related changes in water availability threaten India's power generation capacity. Hydropower, dependent on consistent river flows, and thermal power plants, requiring a steady supply of cool water, are both vulnerable to the effects of a warming climate. Incorporating climate risks into construction planning, particularly for residential and urban projects, is essential for ensuring long-term energy resilience. Sustainable housing designs can integrate energy-efficient solutions, reduce the strain on water resources, and contribute to a more reliable power infrastructure.

Moreover, the health impacts of climate change are already being felt. Rising temperatures, malnutrition, and the spread of vector-borne diseases, particularly in areas that were previously unaffected, are becoming more common. Heatwaves, along with other extreme weather events, are expected to increase mortality and morbidity, especially among the most vulnerable populations. Homes that incorporate passive design principles, natural ventilation, and climate-appropriate materials can help protect residents from these health risks, improving indoor comfort while reducing energy consumption.

The construction sector plays a pivotal role in shaping India's climate future. However, this growth comes with significant environmental consequences, particularly in terms of energy consumption and carbon emissions. Buildings currently account for 40% of global energy use and a quarter of CO_2 emissions, with buildings responsible for 40% of global energy consumption and 33% of greenhouse gas emissions (Sekhar et al.). The 2010 McKinsey estimates confirm that the national power demand can be reduced by as much as 25 percent in 2030 by improving energy efficiency of buildings and operations, making it clear that the future of construction must be sustainable. Green buildings offer a solution, reducing environmental impacts through efficient use of resources and improved building performance.

Figure 1: *Mohali Net Zero Project*
Source: *IIFL HFL*

As India urbanizes rapidly, adopting green building practices is essential to balance development with environmental stewardship. Traditional construction methods often deplete resources and contribute to climate change, making sustainable construction a vital solution. Green buildings focus on energy efficiency, water conservation, and the use of eco-friendly materials while integrating renewable energy systems like solar power and rainwater harvesting. These practices reduce the environmental footprint of buildings and create healthier living spaces by improving air quality, optimizing natural lighting, and lowering utility costs for residents. Climate-resilient homes designed with an understanding of regional climatic conditions are key to India's sustainable future. By incorporating passive design principles such as natural ventilation, thermal insulation, and solar orientation these homes minimize the energy consumption and enhance comfort. In areas prone to extreme weather, resilient designs ensure safety and durability, while also addressing long-term sustainability goals. Such housing not only supports India's climate commitments but also improves the quality of life for residents, making cities more livable and environmentally conscious.

FROM THE CEO'S DESK

Building a Greener Tomorrow

As I reflect on the rapid transformation of our cities and towns, it is evident that we are at a pivotal moment in India's development. Everywhere we look, urban landscapes are evolving at an unprecedented pace—buildings are rising, infrastructure is expanding, and new communities are taking shape. While this growth brings immense opportunities, it also places a profound responsibility on all of us: to ensure that what we build today stands the test of time not just structurally, but environmentally and socially.

At IIFL Home Finance Ltd., we firmly believe that housing is more than just a physical structure—it is the foundation of a better life. A home is where families grow, communities thrive, and aspirations take root. But as we confront the realities of climate change—rising temperatures, extreme weather conditions, and growing resource constraints—we must rethink the way we build. The homes of tomorrow must be resilient, energy-efficient, and environmentally sustainable. This is not merely a vision or a luxury—it is a necessity for the well-being of future generations.

The Green Handbook Volume 2.0 is a key part of our ongoing commitment to bridging the gap between growth and sustainability. More than just a technical document, it serves as a practical guide, empowering homeowners, builders, and communities with the knowledge and tools needed to adopt sustainable building practices. Whether you are constructing a new home, upgrading an existing one, or simply exploring ways to make your living space more eco-friendly, this handbook provides actionable insights to help you make informed choices.

> *"A home is where the families grow, communities thrive, and aspirations take root. But as we confront the realities of climate change rising temperatures, extreme weather conditions, and growing resource constraints we must rethink the way we build."*

When we embarked on this journey, we recognized that addressing India's housing needs—especially in Tier 2 and Tier 3 cities—required more than just innovation. It demanded a fundamental shift in mindset. Sustainable housing should not be viewed as an exclusive privilege for large corporations or high-end developments. Instead, it should be accessible to everyone, from a homeowner planning a modest dwelling to a contractor overseeing a large-scale project.

Through initiatives such as Kutumb and our collaboration with the Asian Development Bank (ADB), we have been working tirelessly to promote affordable and green housing for the communities that need it the most. This handbook is a natural extension of that work, offering practical solutions tailored to India's diverse climates, locally available materials, and traditional building practices.

What excites me most about this handbook is that it goes beyond construction—it is about transformation. It is about empowering people with the tools to build homes that are not only more comfortable, healthier, and energy-efficient but also cost-effective. It proves that sustainability is not just an aspiration but a real, attainable goal—one that benefits both individuals and the planet.

I am incredibly proud of the team and partners who have worked diligently to bring this handbook to life. Their dedication to innovation, practicality, and sustainable solutions is evident on every page. I have no doubt that this resource will play a crucial role in shaping the future of housing in India and beyond.

As we move forward, I encourage each of you to reflect on the long-term impact of the homes we build today. Every decision we make—whether in design, materials, or energy efficiency—shapes not just individual residences but entire communities for future generations. By integrating sustainable practices, we can create homes that are resilient, resource-efficient, and adaptable to changing needs. Sustainable housing is not just an option but a necessity for ensuring healthier living spaces and a greener planet. Together, we have the power to build homes that not only meet present needs but also foster a thriving, livable future. Let us embrace this responsibility and create a lasting legacy of sustainability.

Best,
Monu Ratra
Executive Director & Chief Executive Officer,
IIFL Home Finance Ltd.

ABOUT IIFL HOME FINANCE LTD.

At IIFL Home Finance Ltd., our primary focus is on empowering first-time home buyers, particularly from the Economically Weaker Sections (EWS) and Lower Income Groups (LIG), across 17 states in India. We understand the unique challenges faced by these communities in securing housing, and we are committed to providing them with the support they need to achieve their dream of owning a home.

IIFL Home Finance Ltd. is dedicated to providing affordable home loans, empowering the EWS/LIG segments to achieve homeownership. The company champions eco friendly building practices, promoting sustainable development. With a state of- the-art IT infrastructure offers a seamless loan experience, streamlining the process from application to closure.

The company's asset-light model, enabled by co-lending arrangements, allows expansion of their reach into deeper markets across India. IIFL Home Finance Ltd. goes beyond financing homes. They contribute to building a sustainable and inclusive future, one affordable home at a time.

Our extensive pan-India distribution network spans across Tier 1,2,3 & 4 cities, ensuring our home loan solutions reach both metropolitan areas and smaller towns. This wide reach enables us to serve a diverse customer base, making homeownership accessible to more people. Through this, we aim to positively impact the housing sector and contribute to the economic upliftment of marginalized communities across India.

₹ 38,387 Cr ($ 4.41 BN)
Assets Under Management

2,87,562 +
First Time Home Buyers

₹ 15 Lakh ($ 0.017 MN)
Average Ticket Size

2,48,523+
Women Borrowers/ CO- Borrowers

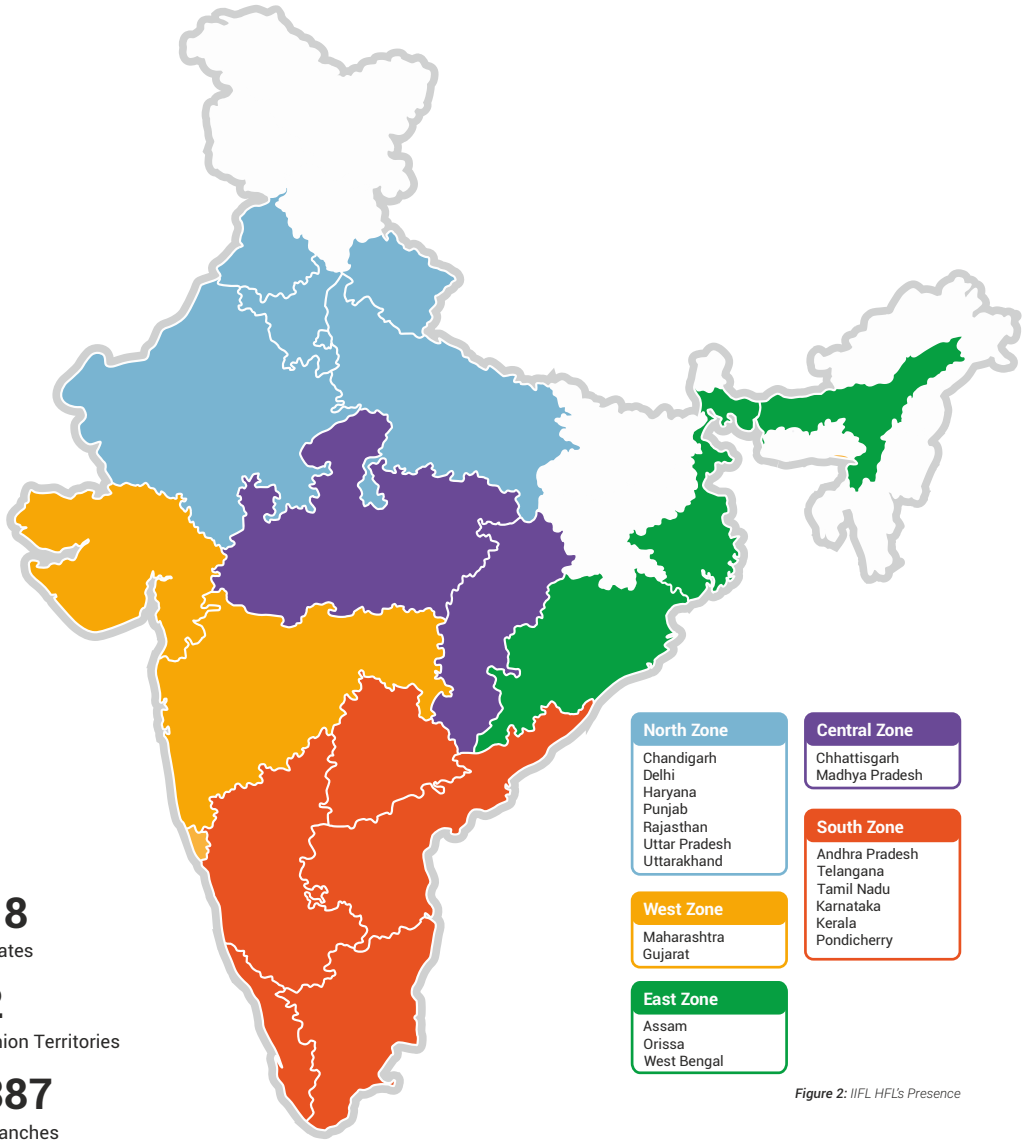
₹ 7,370.34 Cr ($ 0.85 BN)
Value Disbursed

1,54,042+
Loans to Informal Segment

(Data as on December 31st, FY 2024-25)
USD conversion is based on an exchange rate of $1 = 87.11 as of February 4, 2025. Actual rates may vary.

Our Presence

We have an extensive footprint across the country, enabling us to fulfill our commitment of 'Housing for All'.



18
States

2
Union Territories

387
Branches

Figure 2: *IIFL HFL's Presence*

(Data as on December 31st, FY 2024-25)

Our Affordable & Accessible Products

#Sapnonkosachkarnekaseedharaasta

Affordable Home Loan

We provide affordable home loans for purchase, construction, and renovation, making homeownership accessible to a wider audience. With a simple application process, minimal documentation, and quick approvals through our 'Jhatpat' solution, we offer competitive rates and flexible terms, especially for first-time buyers from EWS and LIG. Our goal is to promote financial inclusion and drive economic growth

3,32,349+
Overall Customers

2,87,562+
First Time Home Buyers

₹15.12 Lakh
($ 0.017 MN)
Average Ticket Size

73,000+
Loans to CLSS Beneficiaries

1,54,042+
Loans to People from Informal Sector

26,690+
Loans Disbused to BLC households

15,500+
Loans Disbused to AHP (Affordable Housing Projects)

Secured Business Loan

Our Secured Business Loans offers financial support for small businesses against property collateral. It helps to meet working capital requirements and provides immediate financial assistance for funding business expansion, launching new products and augmenting existing infrastructure. It provides access to larger loan amounts, competitive interest rates and flexible repayment schedules.

₹23.85 Lakh
($ 0.027 MN)
Average Ticket Size

60,691+
MSME's Empowered

₹984.82 Cr
($ 0.11 BN)
Value Disbursed

(Data as on December 31st, FY 2024-25)
USD conversion is based on an exchange rate of $1 = 87.11 as of February 4, 2025. Actual rates may vary.

Shakthi Loan

Sapne poore karney ki Shakthi

Shakthi Loan is a specialized Loan Against Property designed for small businesses in the unorganized sector, like shopkeepers and grocers, offering quick 30-minute approvals for easy access to funds. It supports last-mile micro businesses such as grocery stores, vegetable vendors, and small traders. With lower interest rates, flexible repayment terms, a top-up facility, and simple documentation, Shakthi Loan empowers the economically weaker sections through financial inclusion.

₹4.55 Lakh ($ 0.0052 MN)	₹315.55 Cr ($ 0.036 BN)	68,453+
Average Ticket Size	Value Disbursed	Customers Served

IIFL One Home

One Home

In August 2023, we introduced 'One Home,' an innovative and pioneering B2C and B2B real estate platform designed to facilitate the property journey for individuals and partners alike. This fully digitized platform enables potential buyers to list properties and participate in e-auctions efficiently and effectively. One Home empowers property seekers through its website, while also simplifying auction processes for banks and non-banking financial companies (NBFCs), facilitating the sale of their nonperforming assets (NPAs).

2,800+	₹210 Cr+ ($0.024 BN)
Properties Listed	Properties Sold
₹1,100 Cr+ ($ 0.13 BN)	₹1.7 Cr ($ 0.19 MN)
Properties Managed	Annual Cost Savings for IIFL HFL
6,300+	32,000+
Auctions Published	Platform Visits

Figure 3: *IIFL One Home Features*

(Data as on December 31st, FY 2024-25)

USD conversion is based on an exchange rate of $1 = 87.11 as of February 4, 2025. Actual rates may vary.

LEADING WITH SUSTAINABILITY

At IIFL Home Finance Ltd., sustainability drives our vision and operations. We integrate environmental, social, and governance principles to support diverse stakeholders, from developers to rural communities. Through technical assistance, policy advocacy, and community education, we foster a green, affordable housing ecosystem. Our initiatives go beyond building homes, advancing sustainability, inclusivity, and resilient housing for India's future.

Green Value Partners

The Green Value Partner (GVP) initiative at IIFL HFL was launched in response to the environmental challenges posed by the construction industry, which is a major consumer of non-renewable resources and a significant contributor to CO_2 emissions. The **Green Value Partner (GVP)** initiative by IIFL Home Finance Ltd. addresses the construction sector's environmental challenges by promoting green affordable housing and sustainable practices. By educating developers on energy conservation and green building concepts, GVP empowers communities to implement scalable solutions, fostering innovation and driving a shift toward environmentally friendly construction practices nationwide.

IIFL HFL & Asian Development Bank

Technical Assistance Partnership

IIFL Home Finance Ltd. concluded a Technical Assistance (TA) program of $ 1 Mn, with the Asian Development Bank, to expand affordable green housing in India, funded by the Urban Climate Change Resilience Trust Fund (UCCRTF). This initiative targeted women from EWS and LIG segments, and promoted inclusive, energy-efficient, low-carbon, and climate-resilient housing that meets India's need for sustainable living spaces. The TA program consisted of three lines of delivery in collaboration with experts and select consultants.

Scan to Read the Report

Figure 4: *ADB TA Report*

Objectives of the Technical Assistance

I. Promotion and Propagation of Green Affordable Housing

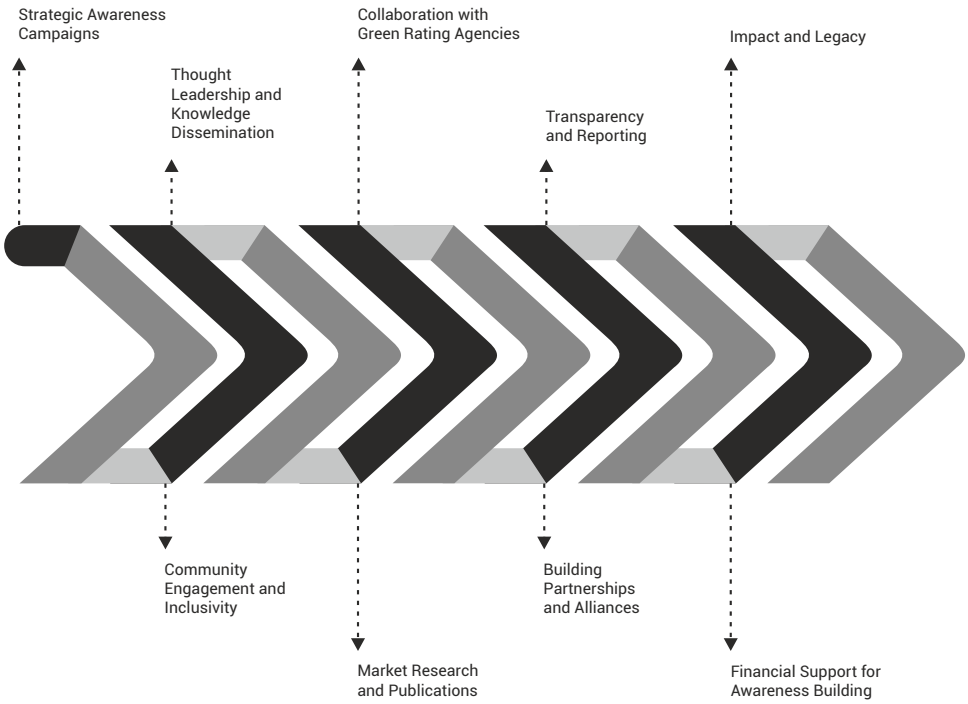


Figure 5: *Promotion and Propagation of Green Affordable Housing*

Kutumb

IIFL Home Loans, in collaboration with the Asian Development Bank (ADB), launched Kutumb to promote sustainable living and eco-friendly construction across India. Through 10 chapters nationwide, Kutumb engaged developers, policymakers, and experts to foster innovation in green building materials, energy efficiency, and waste management. By educating stakeholders on eco-friendly practices, the initiative reduces housing's carbon footprint and enhances quality of life, driving sustainable development in construction and lending.

HUMARA कुटुम्ब करे ग्रीन भारत में गृह प्रवेश

1,220+	660+	95+
Attendees	Developers	Expert Sessions

Disha

DISHA, an initiative by IIFL Home Finance Ltd. in partnership with the Asian Development Bank (ADB), integrates environmental sustainability, social empowerment, and affordable housing to uplift economically weaker sections (EWS) and low-income groups (LIG). Spanning 13 cities and 20 residential welfare associations (RWAs), DISHA promoted eco-friendly construction, green technologies, and community empowerment through workshops and interactive activities. By fostering environmental stewardship and social resilience, it served as a replicable model for sustainable development.

1,100+
Households

1,700+
Saplings Planted

20
EWS/LIG Societies

II. Capacity Building for Green Affordable Housing

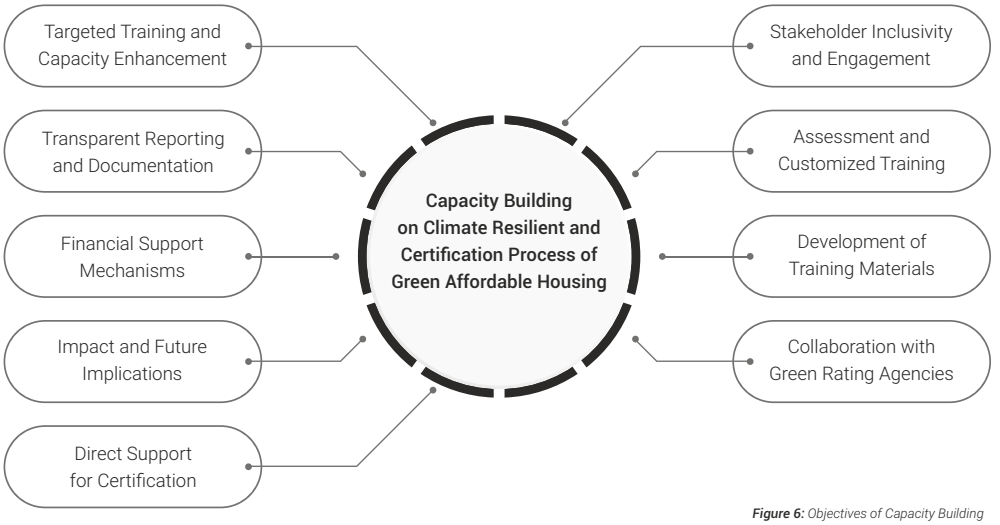


Figure 6: *Objectives of Capacity Building*

Capacity Building for Women's Access to Green and Affordable Housing

Enhancing women's access to green, affordable housing requires robust policy and project frameworks. To address this, IIFL Home Finance Ltd. developed training in four areas: **sustainable housing design, policy for green housing, project appraisal, and green site implementation.** Following a Training Needs Assessment, seven programs across six cities—Pune, Hyderabad, Delhi, Ahmedabad, Jaipur, and Mumbai—engaged participants through interactive sessions. Content, curated via research and

consultations, is now available as self-paced courses on the IIFL Kutumb App.

Do-it-yourself (DIY) Toolkit for Climate Responsive Self Built Affordable Housing

IIFL Home Finance Ltd. developed DIY Toolkits to bridge the knowledge gap in sustainable design and construction for self-built affordable housing. Tailored for homeowners, contractors, and technical representatives, these toolkits address India's four major climate zones: Warm and Humid, Hot and Dry, Composite, and Temperate (excluding cold zones).

Each toolkit covers:

Climate Zone Fundamentals	Insights into environmental conditions.
Passive Design Recommendations	Site- and building-level strategies for energy efficiency.
Sustainable Materials	Eco-friendly construction material options.
Efficient Technologies	Recommendations for energy-efficient appliances.
Waste Management	Practices for sustainable living at home.

These toolkits serve as practical guides to promote sustainable housing practices across diverse climatic regions.

Figure 7.1

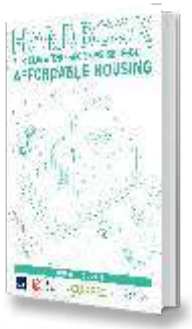


Figure 7.2

Figure 7.3

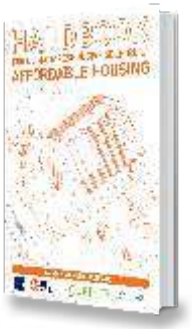


Figure 7.4

Figure 7: *DIY Toolkits*

TEMPERATE	COMPOSITE	HOT & DRY	WARM & HUMID
Scan to Read the Toolkit	Scan to Read the Toolkit	Scan to Read the Toolkit	Scan to Read the Toolkit

III. Advancing Green Affordable Housing Through Research & Innovation

Figure 8: *Key Parameters and Deliverables*

This part of TA project focused on enhancing EWS and LIG access to Green Affordable Housing with a gender-sensitive approach. CARBSE, CRDF executed 14 activities across 8 deliverables.

Key Activities

1. Assessment of Green Building Rating Systems, codes, and standards for Climate Resilient, Climate Responsive, and Gender-Sensitive Housing.
2. Gap analysis and recommendations for improvement to enhance climate resilience and ease adoption.
3. Establishing benchmarks for green building performance during operation, including economic indicators.
4. Mapping decision-making processes to inform actionable interventions for stakeholders.
5. Developing cost assessment methodologies for climate adaptation measures in housing projects.
6. Analyzing energy and resource codes, proposing benchmarks, and suggesting improvements.
7. Identifying innovative and cost-effective green construction technologies.

8. Formulating implementation models, policy recommendations, and strategies tailored to climatic zones.
9. Publishing knowledge products on gender-sensitive and climate-resilient housing best practices.

Humara Kutumb

Humara Kutumb, the next phase of IIFL Home Finance Ltd.'s Kutumb initiative, focuses on grassroots engagement to promote affordable and sustainable housing. It empowers communities with knowledge, tools, and financial support to build eco-friendly homes, particularly for EWS and LIG households. Through workshops, training sessions, and collaborations with local stakeholders, the initiative drives sustainable construction practices, turning sustainability goals into real-world impact.

HUMARA कुटुम्ब
करें ग्रीन भारत में गृह प्रवेश

Demo Houses | Workshops & Training | Green Certifications

Kutumb Pro Mobile App

Kutumb Pro, mobile application, is a platform designed to bring green, affordable housing closer to everyday people, especially homeowners, developers, academia, architects, masons, enthusiasts and communities. It aims to simplify the path to owning sustainable homes by offering practical insights on green design, eco-friendly building practices, and financial options. This app provides resources, courses, engagements, content, case studies and use cases focusing on affordable homeowners' need of knowledge, and creates awareness around sustainable living, while connecting them with industry experts, material suppliers, developers, and designers.

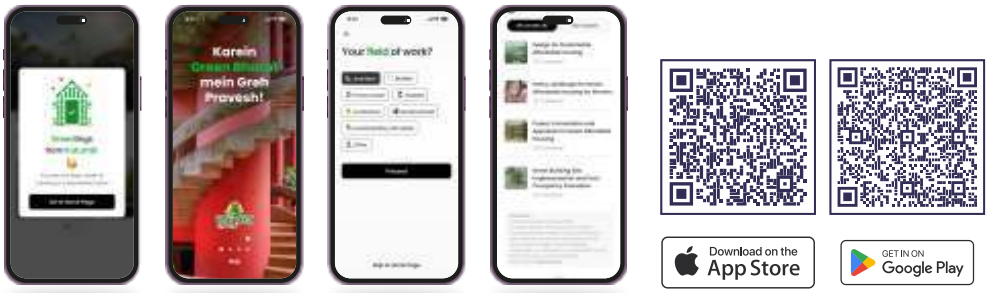


Figure 9: *Kutumb App*

A THROWBACK AT GREEN HANDBOOK *VOLUME 1*

The Green Handbook 1.0 was conceived with the vision of transforming the way homes were designed and built in India. Recognizing the crucial role that sustainable housing played in enhancing quality of life and mitigating environmental impact, the handbook served as a comprehensive guide for developers, architects, construction engineers, and homeowners aiming to create **'GREEN HOMES'**.

In a world where the need for comfortable, healthy, and environmentally friendly homes is more pressing than ever, green homes are seen as not only beneficial for their residents but also as a positive contribution to society by minimizing environmental harm. The Green Handbook 1.0 was developed to bridge the gap between traditional building practices and sustainable alternatives. It provided step-by-step guidance on designing and constructing homes that achieved high environmental performance ratings and qualified for concessional financial assistance.

Our Readers

- **Developers and Architects**
- **Construction Engineers**
- **Homeowners**

Figure 10: *Building Green Handbook*

Co-Author

Ar. Ashok B Lall
Principal Architect,
Ashok B Lall Architects

Essential Themes of the book

1. **Understanding Rating System**
2. **Building Plans and Orientation – Influencing Thermal Comfort**
3. **Building Envelope**
4. **Water Efficiency**
5. **Waste Management and Disposal**

Scan to
Read the Book

Chapters at a Glance

1

Understanding Green Building Rating Systems

Green building certifications like IGBC, GRIHA, and EDGE set benchmarks for energy efficiency, water conservation, and sustainability. They guide developers and homeowners in adopting green practices suited to different housing needs.

2

Building Plans and Orientation for Thermal Comfort

Optimizing site planning and building orientation reduces heat gain and enhances natural ventilation and daylighting, minimizing reliance on artificial cooling and lighting.

3

Building Envelope and Energy Efficiency

A well-designed building envelope with sustainable materials and efficient fenestration reduces heat gain, improves insulation, and lowers energy demand.

4

Water Efficiency and Conservation

Efficient water management, including rainwater harvesting, recycling, and low-flow fixtures, minimizes consumption and ensures long-term sustainability.

5

Waste Management and Recycling

Sustainable waste practices, including reduction, recycling, and on-site composting, minimize environmental impact and promote resource efficiency.

6

Building a Sustainable Green Housing Ecosystem

IIFL Home Finance promotes green housing through initiatives like Kutumb and the Green Value Partner Program, backed by financial incentives and scalable models.

SUPPORTING 'HOUSING FOR ALL'

BUILDING HOMES FOR TOMORROW

Green Handbook Volume 2

Climate change increasingly affects everyday life, resulting in severe weather events such as floods, heatwaves, and droughts. Over 70% of India's housing stock is still under development, and this greatly exacerbates environmental problems. Nature's equilibrium is upset by the materials and energy needed for maintenance, which accounts for 40% of the nation's carbon footprint. Using sustainable building techniques is essential to reducing the effects of climate change and fostering a healthy atmosphere.

Figure 11: *Underdeveloped settlements in India*
Source: *Freepik*

India has committed to reducing carbon intensity by 45 percent over 2005 levels by 2030 and has made a further commitment at COP 26 to achieve net zero emissions by 2070. Reducing housing emissions will be crucial to achieving these goals, as buildings account for about 20% of total carbon emissions and are projected to produce seven times more emissions than 2005 levels by 2050 if not addressed. According to the IFC's Eco-cities India program, residential housing in India accounts for about 24% of the nation's electricity consumption. The IFC estimates a total green housing investment opportunity of US$ 1.25 trillion in India from 2018 to 2030 in the residential sector. Additionally, the 'State of Low-Income Housing Finance Report 2018' indicates that 62% of new housing financed by Affordable Housing Finance Companies (HFCs) in India consists of "self-constructed" standalone houses. This presents a significant opportunity to introduce energy efficiency measures, including building codes, water efficiency, and waste management, into self-built houses.

Understanding Self-Built Housing

Self-built housing is a key aspect of India's housing landscape. Defined as homes constructed by individuals or families using local materials and labor, it encompasses both incremental construction and fully initiated projects. A large portion of housing in India, especially in informal settlements, is self-built, with estimates suggesting around 70% of urban housing falls into this category. This approach offers benefits such as cost control, design flexibility, and community empowerment.

Drivers of Self-Built Housing

Several factors drive the prevalence of self-built housing. Affordability is a primary concern, as high costs associated with formal housing compel families to build their homes, allowing for effective expense management. Cultural practices also play a significant role; many communities have traditions of self-construction, utilizing locally available materials and techniques. Additionally, legal and policy frameworks often create barriers to formal financing and land tenure issues, pushing people toward self-construction.

Challenges in Self-Built Housing

While self-built housing offers advantages, it also presents challenges. Environmental concerns arise from unplanned construction, which can lead to degradation and poor waste management. The quality and safety of many self-built structures may be compromised, as they often lack adequate structural integrity and access to essential services such as water and sanitation. Approximately 70% of houses under the Pradhan Mantri Awas Yojana (PMAY) are built through beneficiary-led construction schemes, reflecting the dominance of self-construction in the housing market.

Figure 12: *Butterfly House - Kalavad, Gujrat*
Source: *IIFL HFL*

The Need for Green Building Practices

With the projected rise in self-built homes, integrating climate-friendly construction methods is imperative. Green building practices can mitigate the construction sector's environmental impact and offer financial savings through energy-efficient designs. As India's population exceeds 1.4 billion, the demand for sustainable housing practices becomes increasingly critical.

Vision for Sustainable Self-Built Housing

The vision for self-built housing in India revolves around creating sustainable, community-driven habitats that blend traditional knowledge with modern ecological principles. This model enables individuals and communities to design homes that cater to local climate conditions and resource availability, reducing

dependency on industrialized construction, which can often be resource intensive and unsustainable. By utilizing locally sourced materials like mud, bamboo, stone, or recycled materials, self-built housing minimizes the environmental footprint, encouraging the use of renewable resources and reducing construction waste. Incorporating green building techniques, such as passive solar heating, natural ventilation, rainwater harvesting, and on-site waste management, these homes become energy-efficient, climate-resilient, and cost-effective. This approach also encourages the revival of local craftsmanship and construction techniques, helping preserve cultural heritage while addressing modern sustainability challenges.

The role of self-built housing is crucial in addressing India's housing shortage, particularly for low income and rural communities, while aligning with the broader goals of sustainability. It fosters social equity by enabling marginalized groups to create affordable housing without relying on external developers, thus democratizing access to home ownership. This approach also encourages community participation and collective problem-solving, promoting social cohesion and resilience. In terms of impact, self-built housing supports Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) by creating inclusive, safe, resilient, and sustainable urban and rural spaces, and SDG 13 (Climate Action) by reducing the carbon footprint and promoting sustainable resource management. Ultimately, self-built housing can become a key component of India's transition to a sustainable built environment, offering scalable, eco-friendly solutions that can be adapted to various regions and communities across the country.

Community Growth and Sustainability

Self-built housing is essential for addressing India's housing shortage, particularly for low-income and rural communities. This model empowers marginalized groups to create homes independently, promoting social equity and democratizing access to home ownership. Moreover, it fosters community participation and resilience, aligning with Sustainable Development Goals (SDGs), especially SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action). Reviving local craftsmanship preserves cultural heritage while addressing modern sustainability challenges.

Sustainable self-built housing is vital to India's housing strategy, addressing the needs of millions while presenting opportunities and challenges. By embracing sustainable practices, supporting financial ecosystems, and implementing enabling policies, India can leverage self-built housing to create a more sustainable future. This Green Building Handbook aims to provide valuable insights and practical guidance for integrating environmentally friendly practices into self-built housing initiatives, ultimately contributing to a healthier and more sustainable living environment for all.

Together With..

Ashok B. Lall Architects

Co-Author

Ashok B. Lall Architects (ABLA) is a pioneering firm in sustainable architecture, dedicated to environmentally conscious design for over three decades. Founded by A.B. Lall, a leading authority in the field, the firm specializes in affordable, climate-responsive solutions that drive India's sustainable building movement. With a strong focus on energy efficiency and ecological responsibility, ABLA's work aligns seamlessly with the mission of the Green Handbook—promoting eco-friendly construction practices for a more sustainable future.

Core Team Members

Ar. Ashok B Lall
Principal Architect,
Ashok B Lall Architects

Ar. Ashok B. Lall developed the house designs for various plot sizes and home configurations. He prepared the design and construction guidelines proposed in the handbook.

Ar. Muskan Choudhary
Ashok B Lall Architects

Ar. Muskan Choudhary assisted Ar. Ashok B.Lall in preparing the graphic material and the text for the handbook.

> *"Every home, no matter how small whether with one, two, or three rooms is built for a lifetime. Each deserves to be thought-fully designed for the comfort and wellbeing of generations to come. This Handbook shows the way.-* **Ashok B. Lall Architects** *"*

Experience & Achievements

Lall's extensive experience includes developing climate-responsive design guidelines for India's diverse climatic zones. These guidelines, accessible through the Bureau of Energy Efficiency, have set new standards for sustainable construction. He has also created specific design solutions for affordable housing under the Pradhan Mantri Awas Yojana (PMAY). Through his video series, "New Vaastu with Ashok Lall," he has made complex architectural concepts accessible to a wide audience.

Why Ashok B. Lall Architects?

A.B. Lall's deep understanding of India's climatic conditions and his commitment to affordable, sustainable housing make him an ideal collaborator for the Green Handbook. His practical approach and focus on real-world solutions align perfectly with the book's goal of empowering small builders and homeowners. His past contributions to sustainable building initiatives demonstrate his ability to deliver effective, accessible solutions.

Reflections on the Green Handbook

Lall believes the Green Handbook is a valuable resource for anyone seeking to build sustainable homes in India. It provides clear, actionable guidance on designing and constructing energy-efficient, climate-responsive buildings. By making complex architectural concepts accessible to a wider audience, the book empowers individuals to create sustainable homes that are both affordable and environmentally friendly.

IIT Bombay

Peer Review & Validation Partner

IIT Bombay, a premier institution in scientific research and technological innovation, played a pivotal role in validating the architectural designs and material recommendations presented in the Green Handbook. Leveraging its extensive expertise in sustainability, energy efficiency, and net-zero technologies, the institute conducted thorough evaluations to ensure that the proposed solutions align with best practices in green building. IIT Bombay's rigorous assessment not only reinforced the technical accuracy of the Handbook but also enhanced its practical applicability, making it a reliable resource for homeowners, builders, and policymakers striving for sustainable and resilient housing solutions.

Core Team Members

Prof. Venkata Santosh Kumar Delhi

Prof. Venkata Santosh Kumar Delhi: A leading expert in sustainable construction, Prof. Venkata led the team in validating the designs for energy efficiency and feasibility.

Prabhat Sharma: A researcher specializing in advanced energy solutions, Sharma's work on Phase Change Materials (PCM) and his team's success in sustainability competitions brought practical insights to the Handbook.

Research Scholar
Prabhat Sharma

Why IIT Bombay?

IIT Bombay's reputation for cutting-edge research in sustainability and its focus on practical applications made it the ideal partner for the Green Handbook. The institute's rigorous validation process ensured the Handbook's technical credibility, making it a reliable resource for builders and architects.

Reflections on the Green Handbook

Prof. Venkata highlighted the collaborative nature of the project, bringing together academic research and practical applications. Sharma emphasized the importance of applying advanced technologies to affordable housing, making the Green Handbook a valuable tool for sustainable building practices.

> *"Incorporating green building techniques, such as passive solar heating, natural ventilation, rainwater harvesting, and on-site waste management, these homes become energy-efficient, climate-resilient, and also cost effective.* - **Prof. Venkata Santosh Kumar Delhi"**

Structure of the Book

This section outlines the structured approach taken to guide homeowners and builders in the sustainable construction process through five interconnected modules. Each module builds on the insights and knowledge from the previous one, creating a cohesive learning path.

Module 1
Building Typologies

1. Purpose: Introduce different ideal building typologies and design principles that promotes suitability

2. Role: Lays the foundation by helping homeowners and builders understand structural options based on climate, materials, and functionality.

Case Studies

The handbook integrates various case studies into its modules to illustrate the principles and practices discussed. These case studies provide practical insights into the application of green building practices, highlighting real-world challenges and successes. These have been interspersed in between the relevant sections of the modules.

Module 2
Materials, Construction Techniques & Elements

1. Purpose: Highlight sustainable materials and construction techniques that enhance durability, efficiency, and environmental impact.

2. Role: Builds on foundational knowledge, guiding homeowners in making informed choices for resilient and cost-effective green homes.

Module 4
Maintenance

1. Purpose: Ensure long-term sustainability through best practices in upkeep, energy optimization, and durability.

2. Role: Reinforces earlier modules by focusing on performance monitoring and maintaining green home benefits over time.

Module 3
Services & Equipments

1. Purpose: Introduce energy, water, and waste management solutions for efficient and sustainable home operations.

2. Role: Connects material choices with smart systems, enabling homeowners to integrate green technologies effectively.

Module 5
Financial Benefits

1. Purpose: Guide homeowners through the process of obtaining certifications and financing for green homes.

2. Role: Completes the learning journey by linking sustainable practices with financial incentives and support mechanisms.

A KEY MESSAGE BY

ASHOK B LALL

Ar. Ashok B Lall,
Principal Architect,
Ashok B Lall Architects

When you are building your own house in a small plot in a township layout, or you are a builder constructing on a township plot, make sure that the building keeps giving benefit throughout its life and its value improves with time. The factors to be considered are discussed below.

Expansion Over Years
(Plan for Adding More Floors)

Year 1

While designing for ground floor, ensure provision for vertical expansion by structural design and staircase.

Figure 13.1

Year 3

Over time, as families expand and requirements change, the terrace can be converted to another floor.

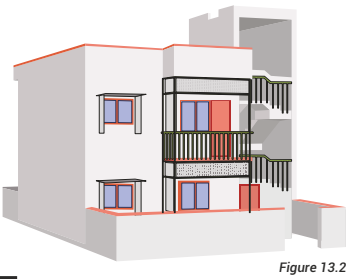


Figure 13.2

Year 7

Eventually your building will be four storeys tall. Demand will grow since many more families need homes close to town.

Figure 13.3

Figure 13: *Incremental Planning*
Source: *Ashok B. Lall Architects*

Staircase Placement

You must plan the staircase for tenants or other owners to reach their upper floors independently and to reach the roof terrace too.

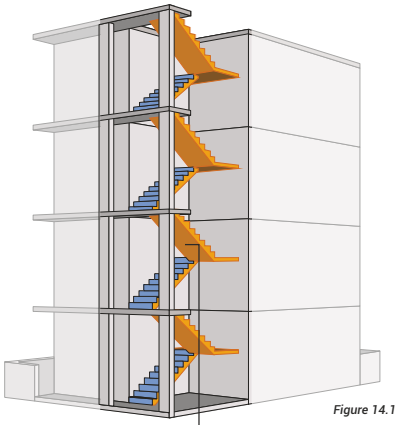


Figure 14.1

Staircase at front allows independant access to all floors

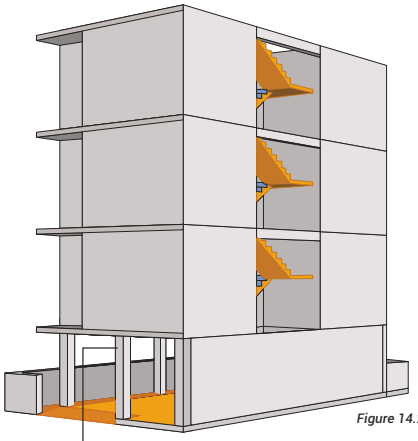


Figure 14.2

Figure 14: *Staircase Placement*
Source: *Ashok B. Lall Architects*

Stilt floor allows flexibility in staircase placement that leads independantly to each floor

Parking

A builder would benefit by building a stilts floor for parking. One can also have a shop or two facing the street with space for parking at the back of the plot. Then one can build three or four storeys on top.

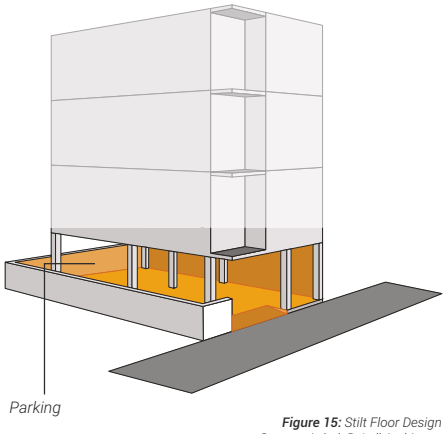
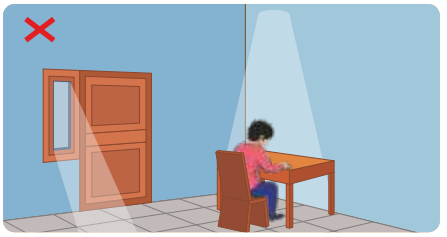


Figure 15: *Stilt Floor Design*
Source: *Ashok B. Lall Architects*

Thermal and Visual Comfort

Everyone prefers homes that are pleasant and well lit with natural light and are reasonably comfortable when the weather is very hot or very cold. To achieve this follow the following steps:

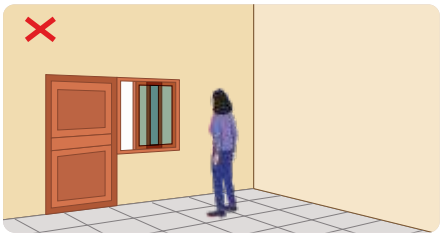
I. Ensure all rooms, bathrooms, and kitchens are well-lit with natural light through windows.



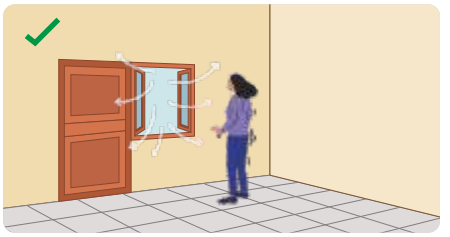
If your room has a very small window or if the window is not rightly positioned or if you have placed some obstruction in front of it, your room will receive inadequate daylight, making you dependant on artificial lighting.

Adequately sized and properly placed windows provide soft, glare free light in your home. You may not even need to switch on the lights during daytime. You save money and live in healthy indoor environment.

II. Ensure that windows can be fully opened to maximize ventilation during favorable weather conditions.



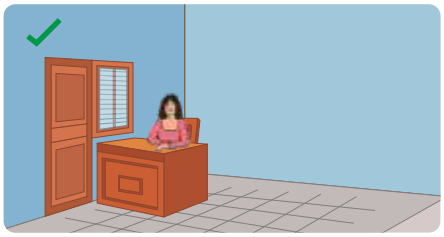
Sliding windows will only give you half the benefit of the actual window opening.



Casement windows will give you full benefit of letting in the pleasant cool air.

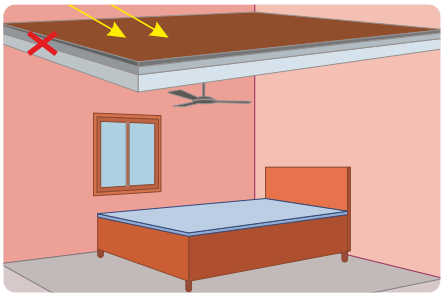
III. Ensure that windows can be effectively shaded from the outside during the hot summer season to enhance cooling and energy efficiency.

The hot sun is pouring in through the window because there is no shading arrangement outside the window. The room gets very hot and glary and then you draw the curtains and switch on the lights.

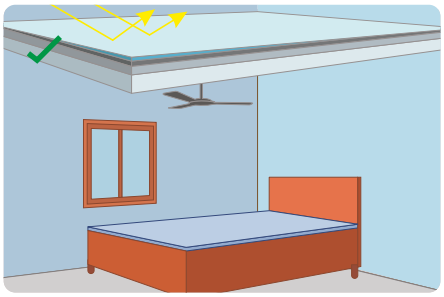


Why should you suffer even though there are windows? You only need to install shading mechanisms outside the windows to overcome this issue. They keep away excess heat and provide soft, glare free daylight inside.

IV. Insulate the roof effectively and finish it with light-coloured paint or tiles to reduce heat absorption.



The roof of your home is a major contributor to heat gain. If left ignored, it becomes very difficult to achieve comfortable indoor temperatures without air conditioning.



A layer of insulation in the roof reduces heat gain to a great extent. Further, finishing the roof with a light colored material reflects back the sunrays instead of absorbing them. Comfortable indoor temperatures can therefore be achieved without air conditioning.

Building Orientation

If and when you have the flexibility to decide the building orientation on a given piece of land, make sure that more walls are exposed to the north and south direction instead of east and west. It is easier to shade northern and southern wall openings. Avoid east and west facing windows to prevent overheating inside your home.

Winter Sun

- Sun path at a low angle, south to E-W axis
- Solar radation will penetrate south facing facades at a low angle during winter

Summer Sun

- Sun path at a high angle sun, north to E-W axis
- Glare free daylight is most easily available on north facade as minimal solar radation will fall at high angle
- Easy shading of south facade from high angle sun

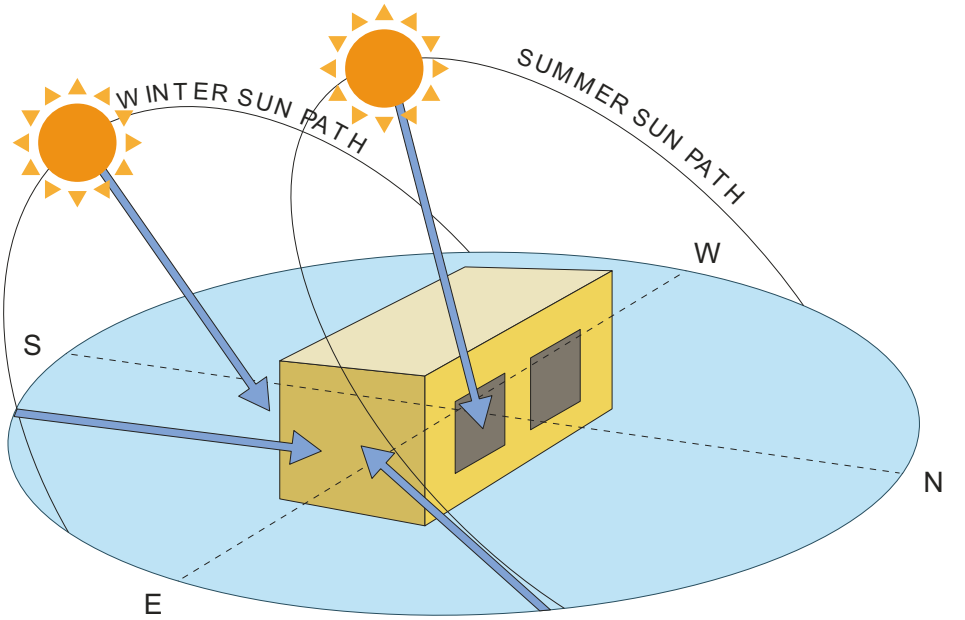


Figure 16: *Solar path over a typical home during winters and summers*
Source: *https://nzeb.in/knowledge-centre/passive-design/form-orientation/*

East and west facades continue to receive uniform, strong solar radiation at a low angle through the year.

Energy Efficiency

Electricity will become more and more expensive. Everyone wants homes that do not depend on air conditioners and artificial light much of the time. The use of electricity is reduced if you 'make sure' what is suggested above.

Structural Stability

Everyone wants to know that the building they will be living in is structurally safe. A good structural engineer will design the most economical foundation and structure. A good design will not use more than 28 kg of reinforcement steel per sqm. of gross built-up area.

MODULE I

BUILDING TYPOLOGIES

This module serves as a manual for homebuilders providing guidance on building typologies and design principles.

TABLE OF CONTENTS

IN THIS MODULE...

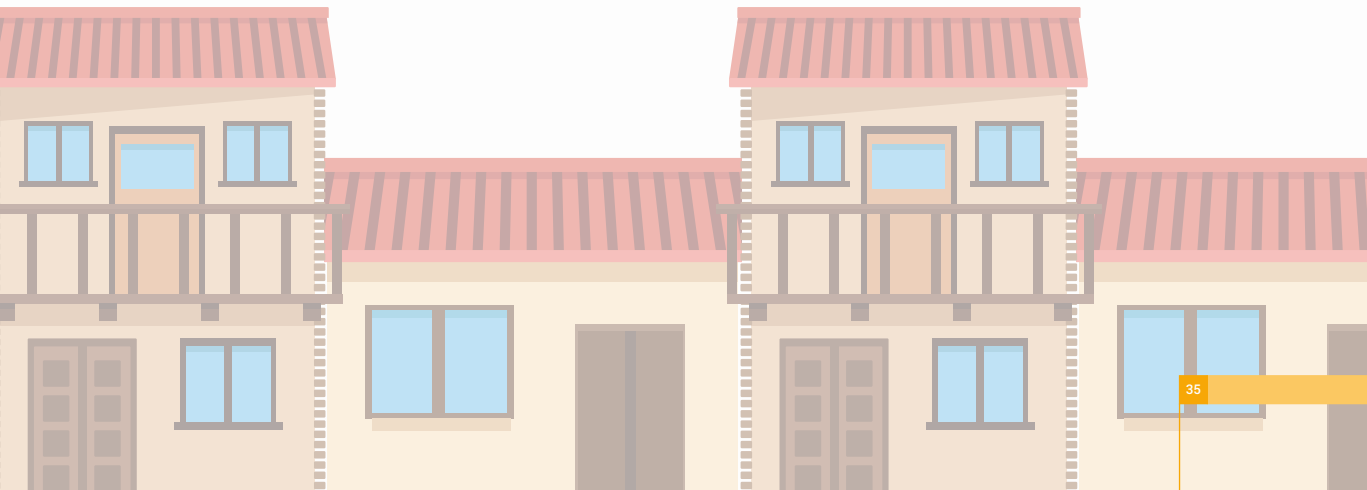
...you will discover valuable insights on selecting the ideal building typologies and design principles that best suit your needs and promote sustainability. This module will provide you with the tools to make informed decisions about the layout and design of your home, ensuring it is not only functional but also energy efficient and environmentally friendly. You will explore various building typologies or designs tailored to plot sizes from **44 sqm to 340 sqm**, allowing for efficient use of space. The List for plot sizes shows the 9 typical plot size options within the above mentioned range, with design layout created by the Architect, Ashok B. Lall using sustainable and passive design features. Users can explore the nine type designs options to find house plans tailored to their chosen plot size and accommodation type, simplifying the process of selecting the design that best fits their plot. The designs accommodate a range of needs, offering three types of living spaces and accommodation options:

- **RK:** One room with a kitchen and toilet
- **1 BHK:** One bedroom with a hall, kitchen, and toilet
- **2 BHK:** Two bedrooms with a hall, Kitchen and toilet

Users can also combine adjacent small plots to create a larger one, which reduces the number of staircases needed. This not only saves on construction costs but also increases usable living space. For larger plots, you can have more than one flat on each floor.

Additionally, the module will guide you through essential design principles, such as passive design strategies, which optimize natural light, airflow, and thermal comfort while reducing reliance on artificial energy sources. Simulation of all design types are done to investigate the thermal performance of the architectural drawings and materials and analyse the thermal comfort hours for each respective design for three climatic conditions considered for the study, i.e., warm & humid (Vishakhapatnam, Andhra Pradesh), Hot & Dry (Gandhinagar, Gujarat), and composite climate (Indore, Madhya Pradesh). The simulation process includes a typical case (commonly observed across pan-India) and two proposed options to assess the impact on comfort hours. Additionally, a framework is provided for the impact assessment using a measurement matrix of the suggested design types, construction materials and technologies with respect to energy savings. The parameters/ checklist can ensure that your home is sustainable, environmentally conscious and eligible for 'green certification'.

With this knowledge, you'll be able to create living spaces that are both practical and sustainable, maximizing comfort, minimizing waste, and promoting long-term environmental responsibility. By the end of this module, you will have the foundation needed to design homes that are efficient, sustainable, and well-suited to the changing needs of modern living.



INTRODUCTION

Creating homes that are both functional and sustainable is essential, particularly in small and compact township layouts. Incorporating practical design features, such as independent access to upper floors and versatile terraces, can make homes adaptable for growing families or rental opportunities. Strategically positioned windows not only maximize natural light and ventilation but also reduce reliance on artificial systems, leading to lower energy costs. By focusing on flexibility, sustainability, and community integration, we can develop spaces that meet diverse needs while promoting environmental responsibility.

On the other hand , for larger plots, stilt floors serve dual purposes by providing parking while enhancing natural light and space usage. Thoughtful building orientation, with walls facing north and south, minimizes exposure to direct sunlight, ensuring cooler interiors without excessive energy use.

From compact studio apartments to more spacious 2BHK units, there's a focus on optimizing space and saving costs. Combined plot options are also explored to enhance efficiency. With practical advice on electrical and water systems, this guide offers a blueprint for building homes that not only meet today's needs but also grow in value over time.

LIST OF PLOT TYPES

It has been seen that there is a wide range of different plot sizes on which builders or home-owners build homes. Out of this wide range of plots, some typical ones that represent different segments of this range have been developed in this handbook for the user's reference.

However, there are some basic principles of design that have been followed for all plots and dwelling units.

If your plot size does not exactly match any of the options provided in this handbook, use the closest option available and adapt it to your requirements using the principles explained below.

Type 1 Plot Size: 44 Sq.m. (5.5m X 8m)

The smallest module of a home is a studio apartment (or 'RK' which refers to Room & Kitchen). It is designed for its minimum space requirements and basic neccessities to arrive at the minimum plot size required for you to build a livable home.

Type 1 A- Studio (RK)

Dwelling Unit Size: 20 Sq. m.

PLOT FACING A NARROW STREET (<5M) If the front street, on which the plot is located, has a width less than 5m, there should be no projection outside the plot boundary. This is important to ensure adequate daylight and ventilation for the home.

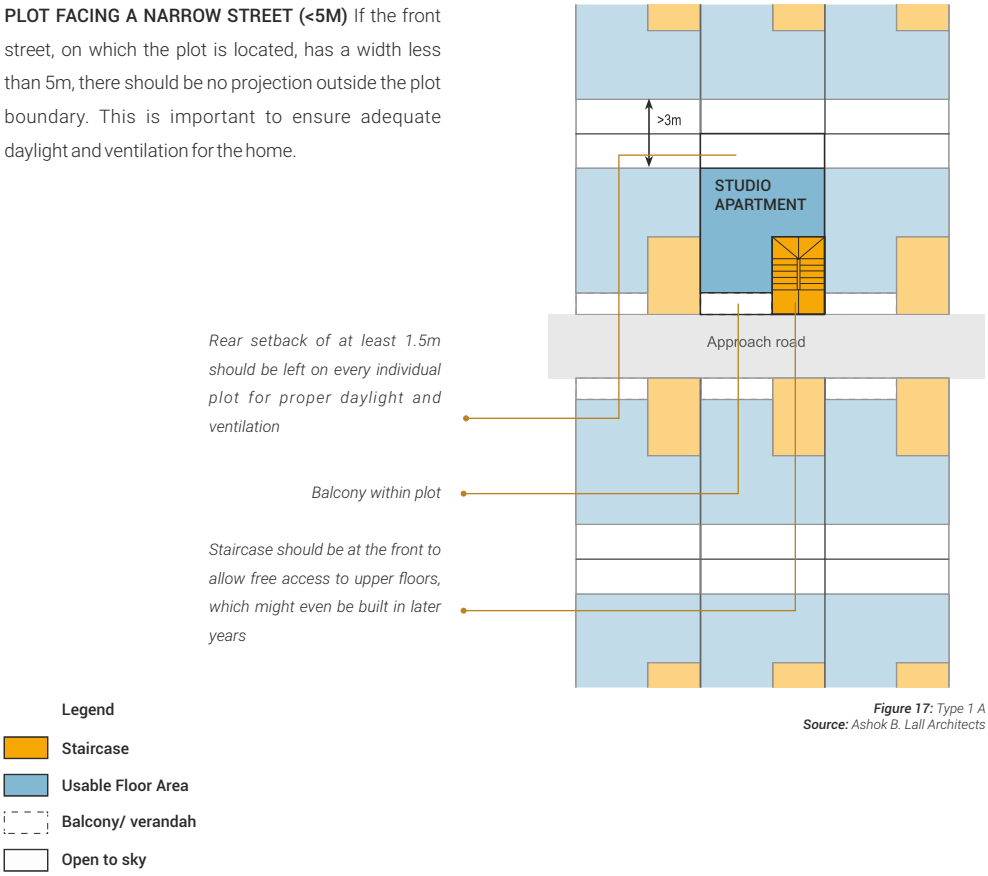


Figure 17: *Type 1 A*
Source: *Ashok B. Lall Architects*

TYPE 1 A

Studio Plot Size: 44 Sq.m. (5.5m X 8m)
Carpet Area: 20 Sq.m.

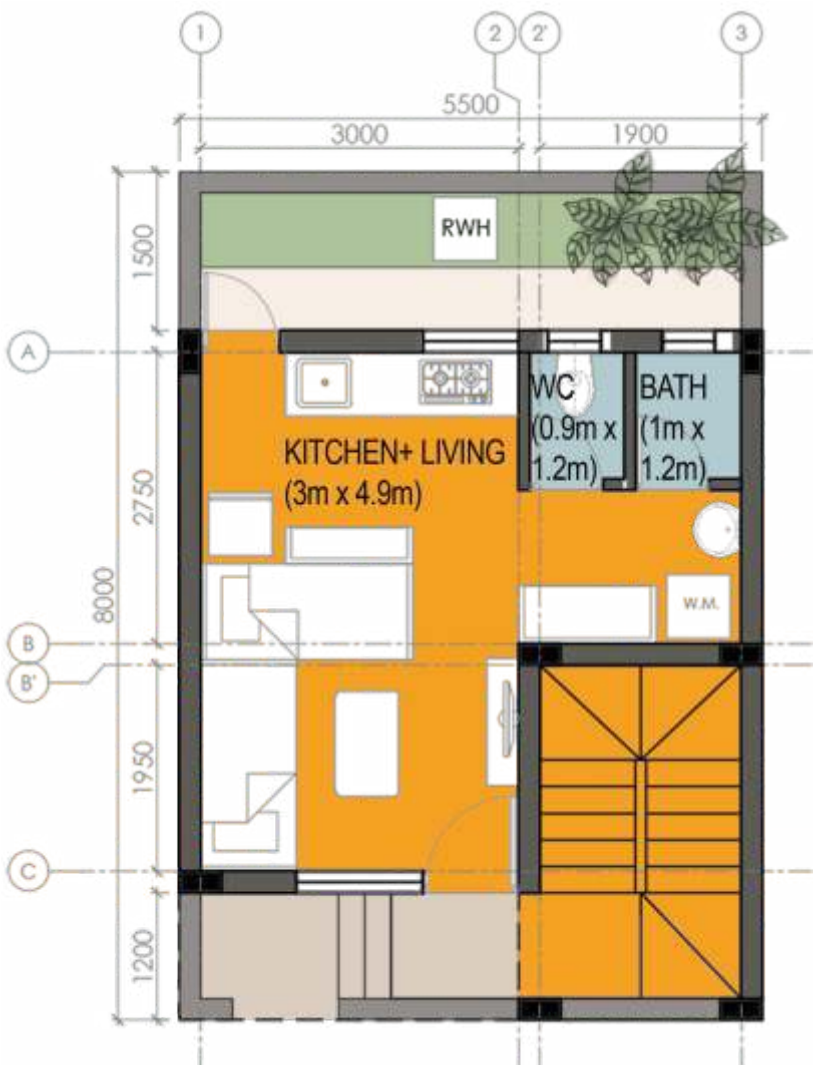


Figure 18: *Typical ground floor plan of Type 1A dwelling unit*
Source: *Ashok B. Lall Architects*

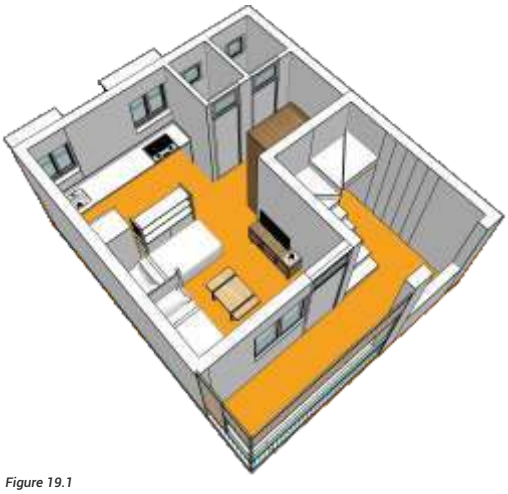


Figure 19.1

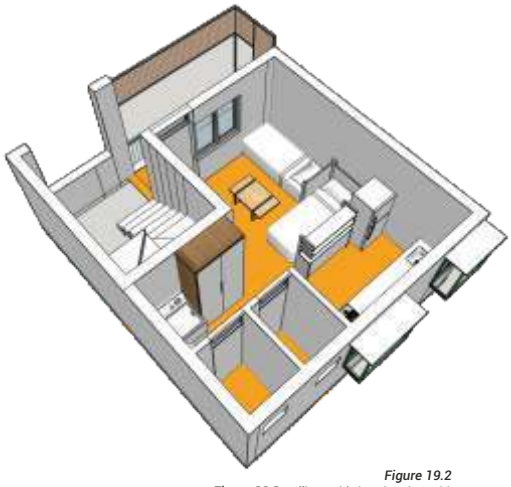


Figure 19.2

Figure 19:*Dwelling unit's interior views 1A*

A builder or plot owner can make two storeyed apartment using this unit type design. The image shows such a scenario.

Figure 20: *Building's Exterior View Type 1A*
Source: *Ashok B. Lall Architects*

Type 1 AA- Studio

Dwelling Unit Size: 22.6 sq.m. each

Two similar plots (Jodi Plots) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

NOTE: THE 'JODI'-PLOT- 'PAIRED ADJACENT PLOTS'

There's some good news for you! As allowed in some towns and cities by the local building byelaws, you can amalgamate 2 small plots (within prescribed area limits) to form a single larger plot. For example, the Delhi building bye-laws permits amalgamation of 2 plots of up to 64sqm each to get a maximum plot size of 128sqm.

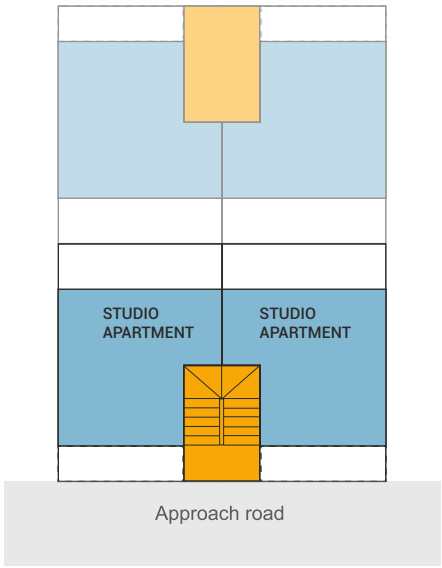


Figure 21: *Type 1 AA*

Figure 22: *Building's Exterior View Type 1AA*
Source: *Ashok B. Lall Architects*

Figure 23: *Typical ground floor plan of Type 1AA dwelling unit*

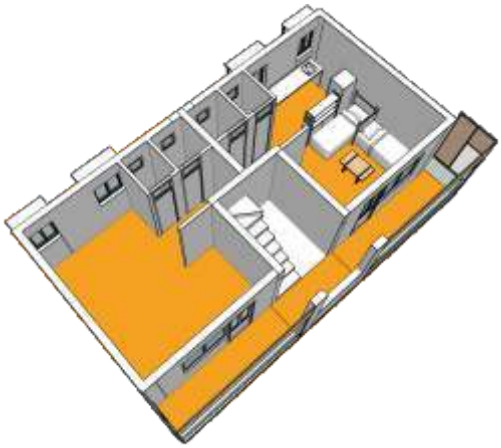


Figure 24.1

Figure 24.2

Figure 24: *Dwelling unit's interior views TYPE 1AA*
Source: *Ashok B. Lall Architects*

Type 1 B- Studio (RK)

Dwelling Unit Size: 24 Sq. m.

PLOT FACING A WIDE STREET (>5M)

If the front street, on which the plot is located, is more then 5m wide, the balconies can project out of the plot boundary (only if the local regulations and practices permit) to get an increased floor space on the same plot size.

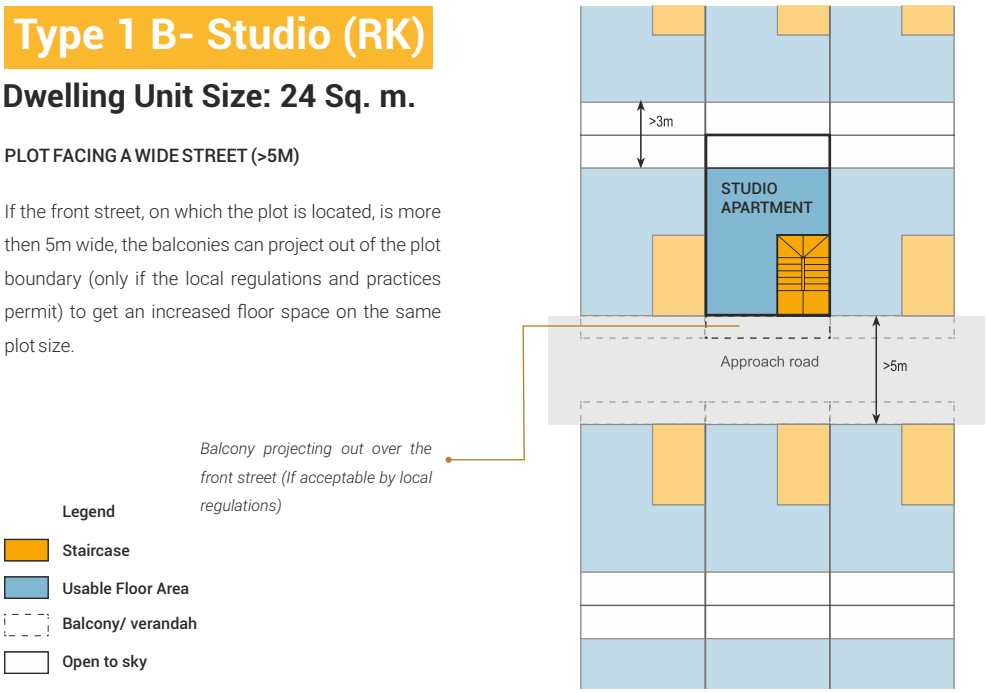


Figure 25: *Type 1 B*

Figure 26: *Building's Exterior View Type 1B*
Source: *Ashok B. Lall Architects*

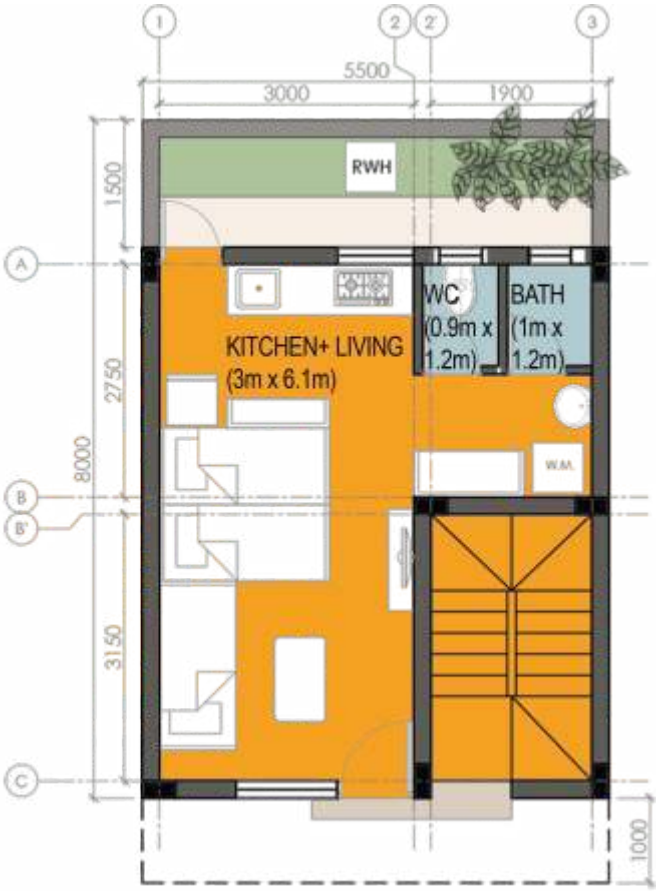


Figure 27: *Typical ground floor plan of Type 1B dwelling unit*
Source: *Ashok B Lall*

Figure 28.1

Figure 28.2
Figure 28: *Dwelling unit's interior views TYPE 1B*
Source: *Ashok B. Lall Architects*

Type 1 BB- Studio

Dwelling Unit Size: 27.6 Sq.m. Each

Two similar plots (Jodi plots) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

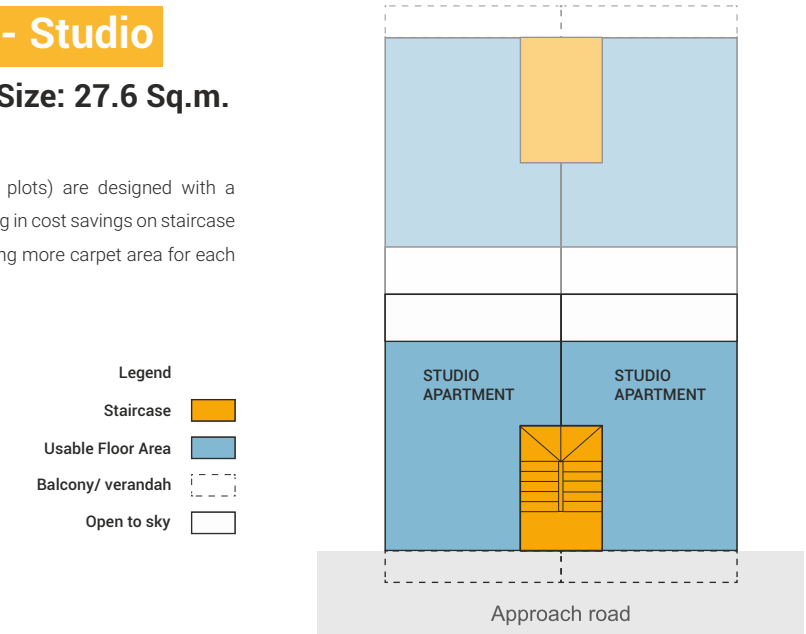


Figure 29: *Type 1 BB*

Figure 30: *Building's Exterior View Type 1BB*
Source: *Ashok B. Lall Architects*

Figure 31: *Typical ground floor plan of Type 1BB dwelling unit*

Figure 32.1

Figure 32.2

Figure 32: *Dwelling unit's interior views type 1BB*
Source: *Ashok B. Lall Architects*

Type 2 Plot Size: 60 Sq.m. (6m X 10m)

A 1BHK dwelling unit is designed for its minimum space requirements in a minimum plot area. If your plot is smaller than this minimum area, you should preferably build a spacious studio apartment and not a 1BHK home.

Type 2A- 1BHK

Dwelling Unit Size: 34 Sq. m.

PLOT FACING A NARROW STREET (<5M)

If the front street, on which the plot is located, has a width less than 5m, there should be no projection outside the plot boundary. This is important to ensure adequate daylight and ventilation for the home.

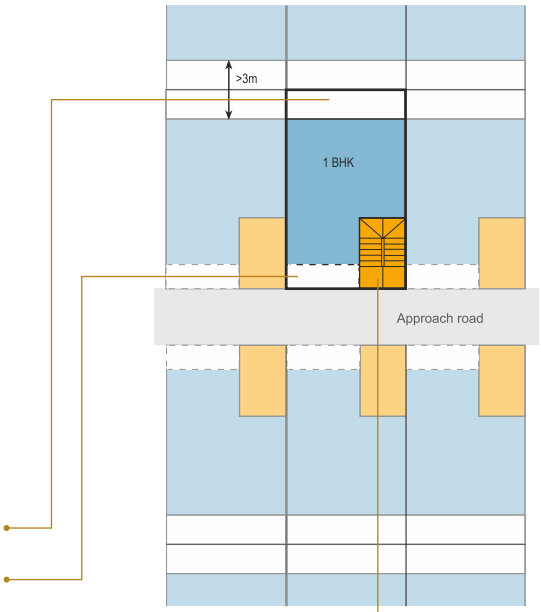


Figure 33: *Type 2A*

Figure 34: *Building's Exterior View Type 2A*
Source: *Ashok B. Lall Architects*

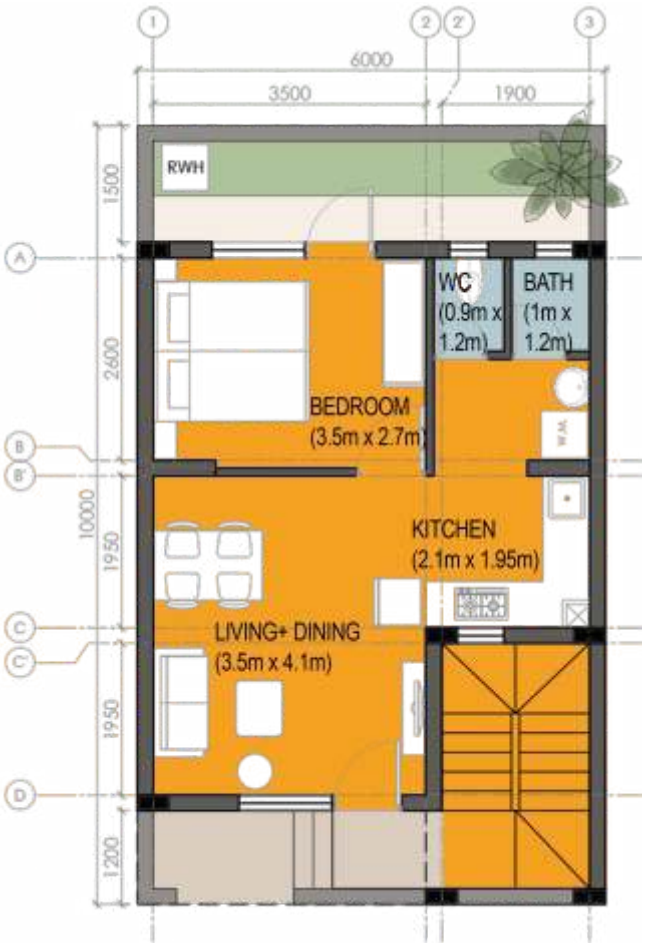


Figure 35: *Typical ground floor plan of Type 2A dwelling unit*

Figure 36.1

Figure 36.2

Figure 36: *Dwelling unit's interior views type 2A*
Source: *Ashok B. Lall Architects*

Type 2AA- 1BHK

Dwelling Unit Size: 36.5 Sq.m. Each

Two similar plots (Jodi-Plot) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

Legend

- Staircase
- Usable Floor Area
- Balcony/ verandah
- Open to sky

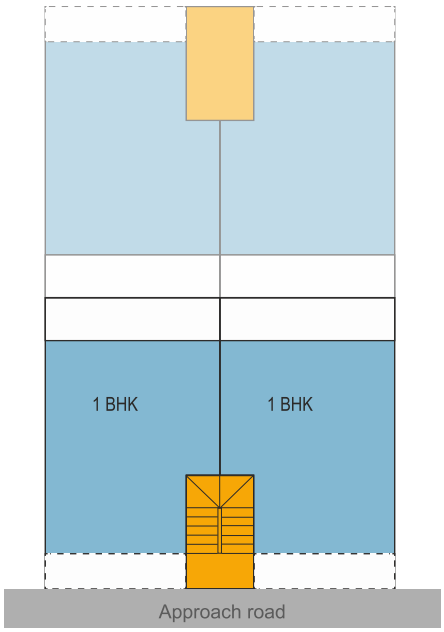


Figure 37: *Type 2AA*

Figure 38: *Building's Exterior View Type 2AA*
Source: *Ashok B. Lall Architects*

Figure 39: *Typical ground floor plan of Type 2AA dwelling unit*

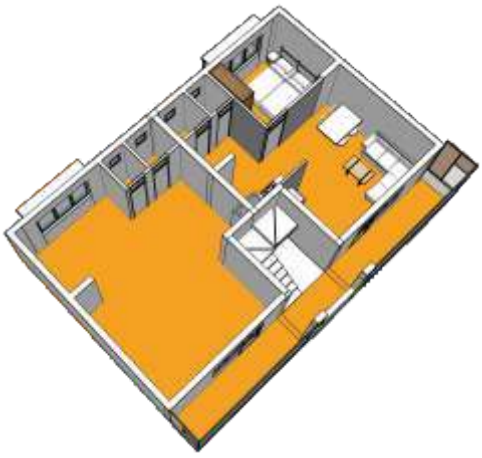


Figure 40.1

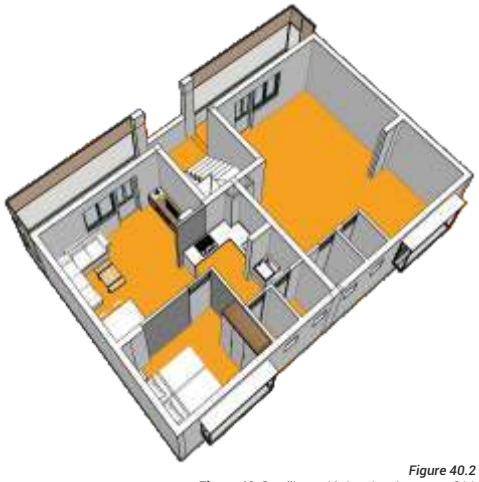


Figure 40.2

Figure 40: *Dwelling unit's interior views type 2AA*
Source: *Ashok B. Lall Architects*

Type 2B- 1BHK

Dwelling Unit Size: 38 Sq. m

PLOT FACING A NARROW STREET (>5M)

If the front street, on which the plot is located, is more than 5m wide, the balconies can project out of the plot boundary (only if the local regulations and practices permit) to get an increased floor space on the same plot size.

Balcony projecting out over the front street (If acceptable by local regulations)

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

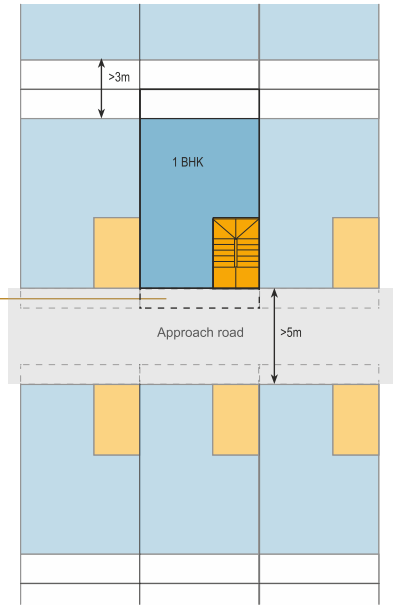


Figure 41: *Type 2B*

Figure 42: *Building's Exterior View Type 2B*
Source: *Ashok B. Lall Architects*

Figure 43: *Typical ground floor plan of Type 2B dwelling unit*

Figure 44.1

Figure 44.2

Figure 44: *Dwelling unit's interior views type 2B*
Source: *Ashok B. Lall Architects*

Type 2BB- 1BHK

Dwelling Unit Size: 42 Sq.m. Each

Two similar plots (Jodi Plot) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

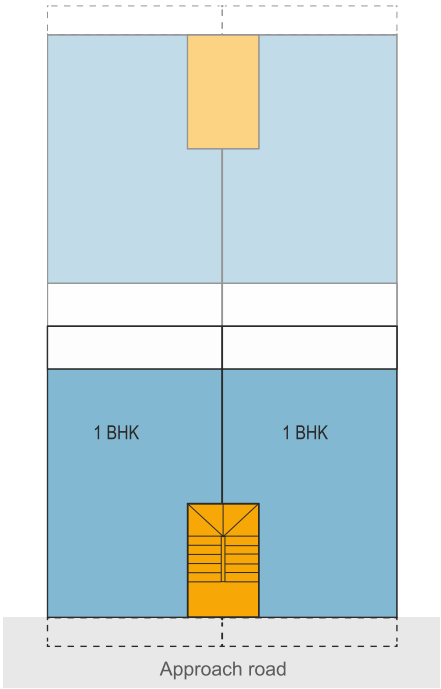


Figure 45: *Type 2BB*

Figure 46: *Building's Exterior View Type 2BB*
Source: *Ashok B. Lall Architects*

Figure 47: *Typical ground floor plan of Type 2BB dwelling unit*

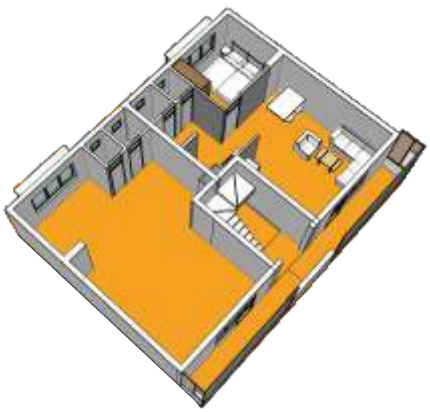


Figure 48.1

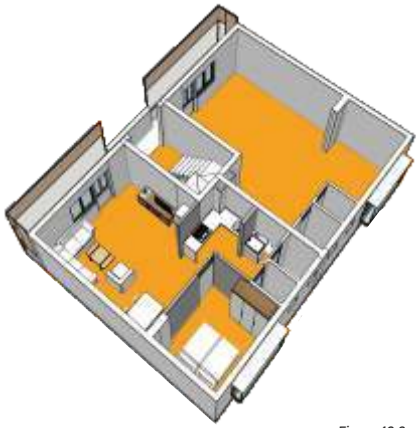


Figure 48.2

Figure 48: *Dwelling unit's interior views type 2BB*
Source: *Ashok B. Lall Architects*

Type 3 Plot Size: 90 Sq.m. (7.5m X 12m)

A 2BHK dwelling unit is designed over a stilt parking floor.

If you have a parking requirement, then you should construct a stilt floor. This stilt floor also has another benefit. It allows for the staircase to occupy that location of the home which would otherwise be dark and ill-ventilated. So you get more floor space that receives natural daylight and ventilation.

Type 3- 2BHK

Dwelling Unit Size: 45 Sq. m.

Rear setback of at least 1.5m should be left on every individual plot for proper daylight and ventilation

If the building accommodates 3 rooms or more in its depth, it should have a side setback of at least 1.5m so that natural daylight can reach all parts of the building.

Staircase occupies the least favourable location for a habitable space.

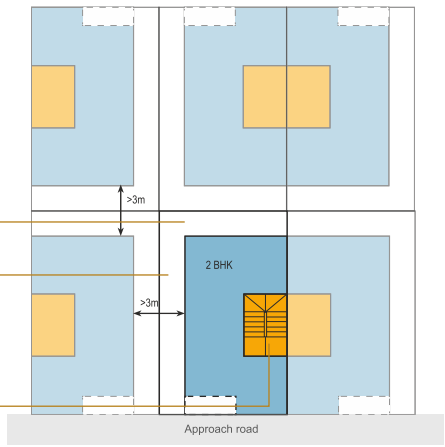


Figure 49: *Type 3*

Figure 50: *Building's Exterior View Type 3*
Source: *Ashok B. Lall Architects*

Figure 51: *Stilt Floor Plan of Type 3*

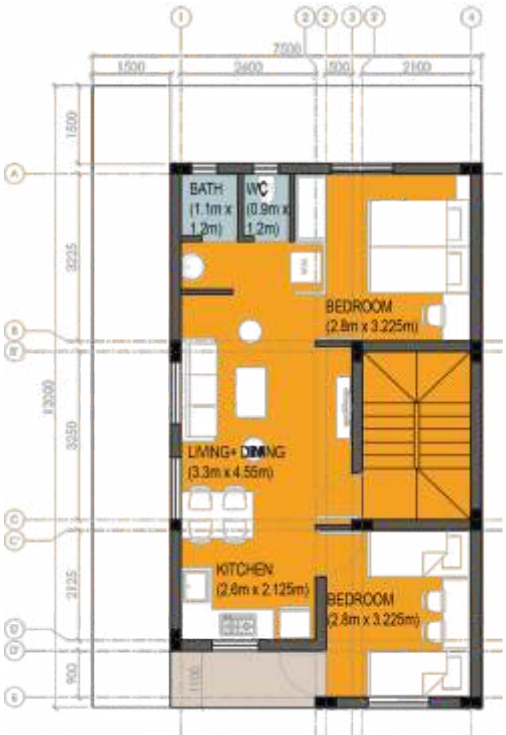


Figure 52: *Typical ground floor plan of Type 3 dwelling unit*

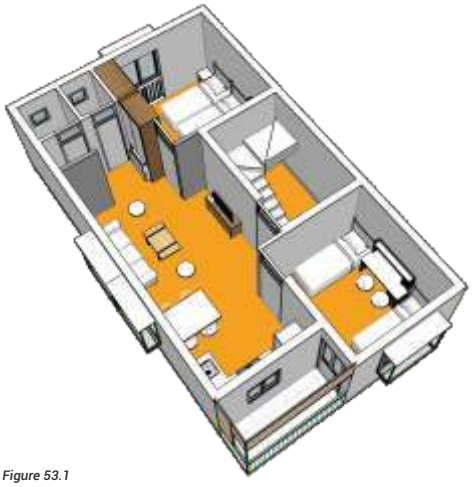


Figure 53.1

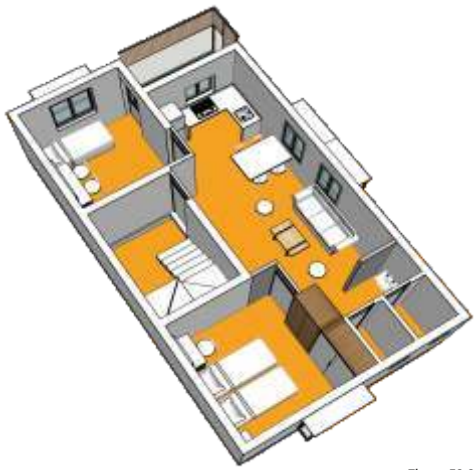


Figure 53.2

Figure 53: *Dwelling unit's interior views type 3*
Source: *Ashok B. Lall Architects*

Type 3-3'- 2BHK

Dwelling Unit Size: 50 Sq.m. Each

Two similar plots (Jodi Plot) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

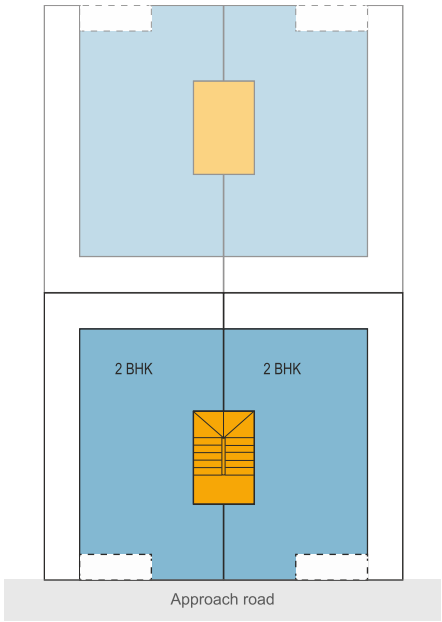


Figure 54: *Type 3-3*

Figure 55: *Building's Exterior View Type 3-3*
Source: *Ashok B. Lall Architects*

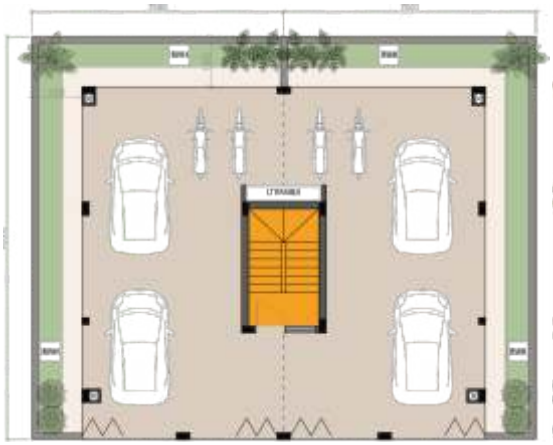


Figure 56: *Stilt Floor Plan of Type 3-3*

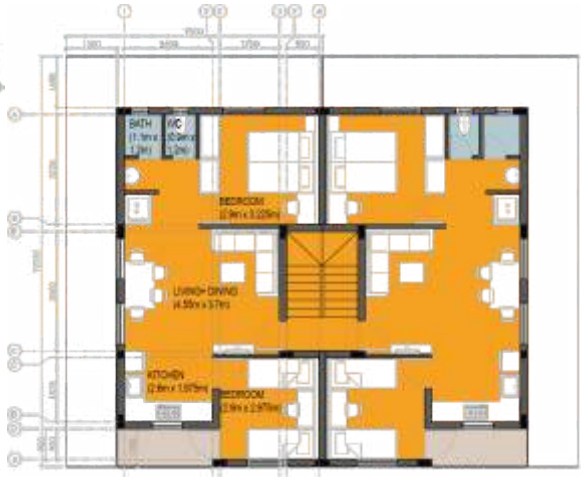


Figure 57: *Typical ground floor plan of Type 3-3 dwelling unit*

Figure 58.1

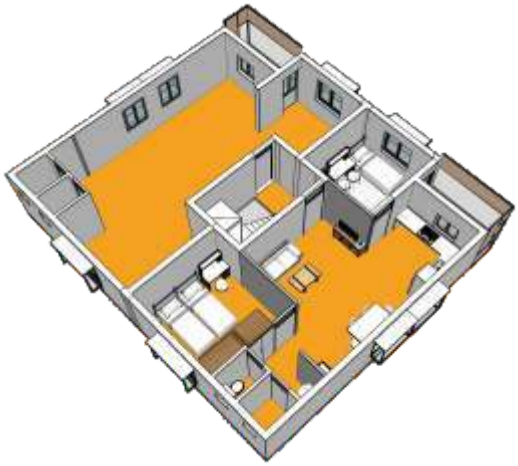


Figure 58.2

Figure 58: *Dwelling unit's interior views 3-3*
Source: *Ashok B. Lall Architects*

Type 4 Plot Size: 90 Sq.m. (7.5m X 12m)

A 2BHK dwelling unit is designed without a stilt parking floor.

If you do not want to construct a stilt floor, you get a different layout for your 2BHK home. In this case, when the staircase comes at the front, you must give a light and ventilation shaft as shown.

Type 4- 2BHK

Dwelling Unit Size: 42.5 Sq. m.

Provide a courtyard at the location which would otherwise be dark and non-ventilated.

Staircase should be at the front to allow free access to upper floors, which might even be built in later years.

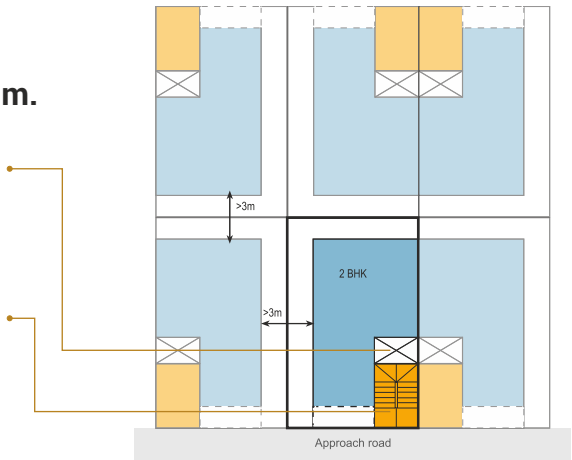


Figure 59: *Type 4*

Figure 60: *Building's Exterior View Type 4*
Source: *Ashok B. Lall Architects*

Figure 61: *Typical ground floor plan of Type 4 dwelling unit*

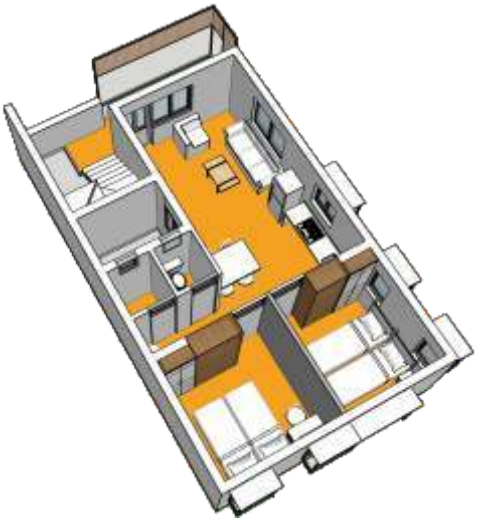


Figure 62.1

Figure 62.2
Figure 62: *Dwelling unit's interior views type 4*
Source: *Ashok B. Lall Architects*

Type 4-4'- 2BHK

Dwelling Unit Size: 42.5 Sq.m. Each

Two similar plots (Jodi Plot) are designed with a shared staircase, resulting in cost savings on staircase construction and providing more carpet area for each home.

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

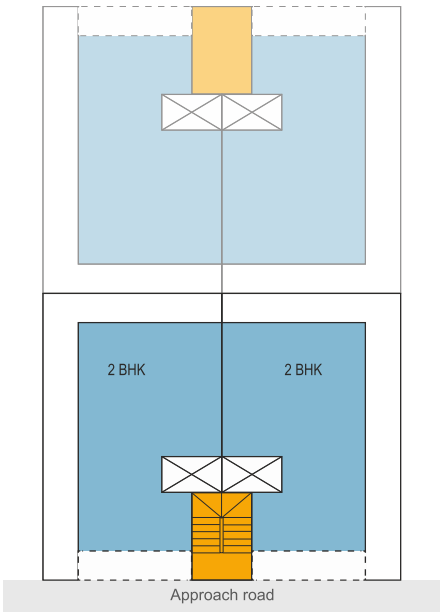


Figure 63: *Type 4-4'*

Figure 64: *Building's Exterior View Type 4-4'*
Source: *Ashok B. Lall Architects*

Figure 65: *Typical ground floor plan of Type 4-4 dwelling unit*

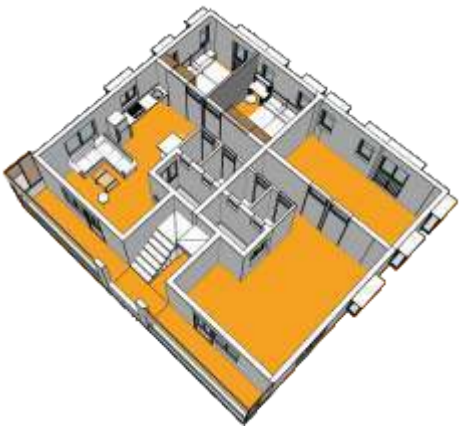


Figure 66:.1

Figure 66:.2

Figure 66: *Dwelling unit's interior views type 4-4*
Source: *Ashok B. Lall Architects*

Type 5 Plot Size: 126 Sq.m. (9m x 14m)

2 Nos. of 1 BHK homes are built on the same floor. Both the units open on the front street. The planning remains the same whether or not you want to construct a stilt floor.

Type 5- 2 Nos. of 1BHK Homes

Dwelling Unit Size: 31.5 Sq. m. Each

Rear setback of at least 1.5m should be left on every individual plot for proper daylight and ventilation

The courtyard ensures daylight and ventilation in the middle portion of the building which would otherwise have no relationship with the outside

According to building bye-laws, large plots are required to leave a front setback of at least 3m

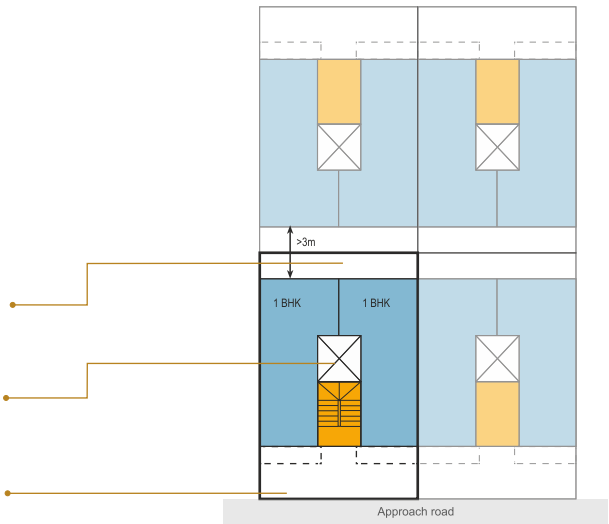


Figure 67: *Type 5*

Figure 68: *Building's Exterior View Type 5*
Source: *Ashok B. Lall Architects*

NOTE: MULTIPLE DWELLING UNITS

If you are a builder who has a large plot, then you should consider constructing a building that houses multiple dwelling units on each floor. Depending on the plot size, you can plan 2-4 homes per floor, reaching a maximum of 16 homes on 4 floors, making each home an affordable one.

Figure 69: *Stilt Floor Plan of Type 5*

Figure 70: *Typical ground floor plan of Type 5 dwelling unit*

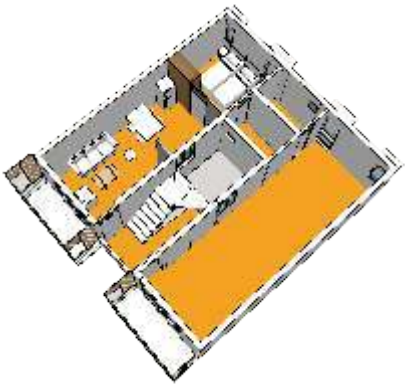


Figure 71.1

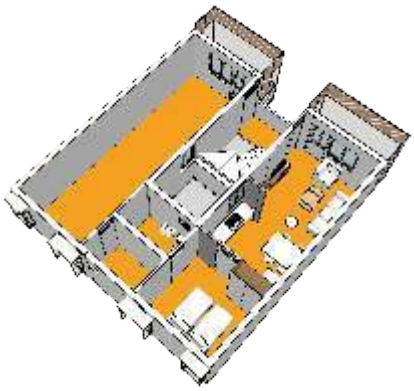


Figure 71.2

Figure 71: *Dwelling unit's interior views type 5*
Source: *Ashok B. Lall Architects*

Type 6 Plot Size: 200 Sq.m. (10m X 20m)

2 Nos. of 2 BHK homes are built on the same floor. Only one of the units gets a street frontage.

Type 6- 2 Nos. of 2BHK Homes

Dwelling Unit Size: 46 Sq. m. Each

Where one of the dwelling units do not get a road frontage, the rear setback should be a minimum of 3m

If the building accommodates 3 rooms or more in its depth, it should have a side setback of at least 1.5m so that natural daylight can reach all parts of the building

Courtyards are provided to ensure daylight and ventilation to the middle portions of the building

According to building bye laws, large plots are required to leave a front setback of at least 3m

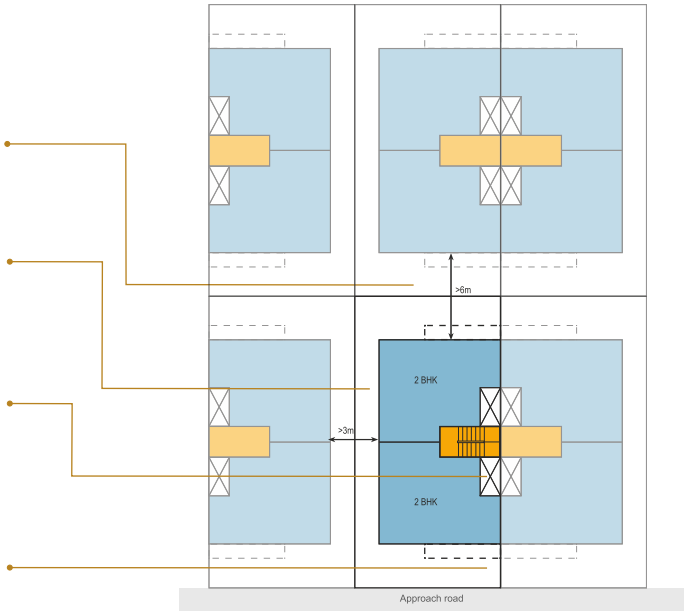


Figure 72: *Type 6*

TYPE 6- 2 NOS. OF 2BHK HOMES

Plot Size: 200 Sq.m. (10m X 20m)
Carpet Area: 46 Sq.m. Each

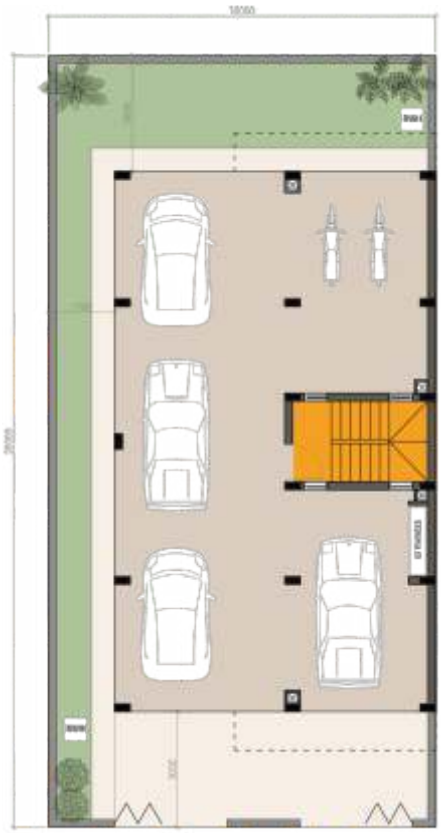


Figure 73: *Stilt Floor Plan of Type 6*

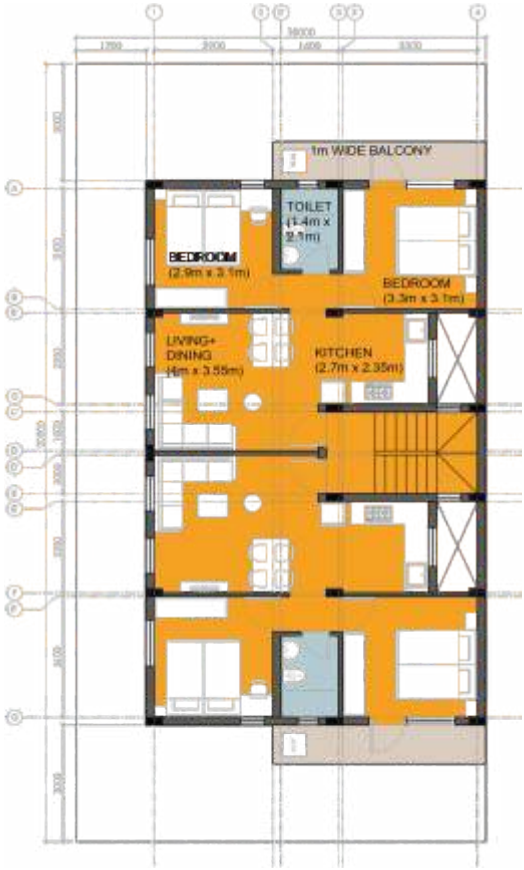


Figure 74: *Typical ground floor plan of Type 6 dwelling unit*

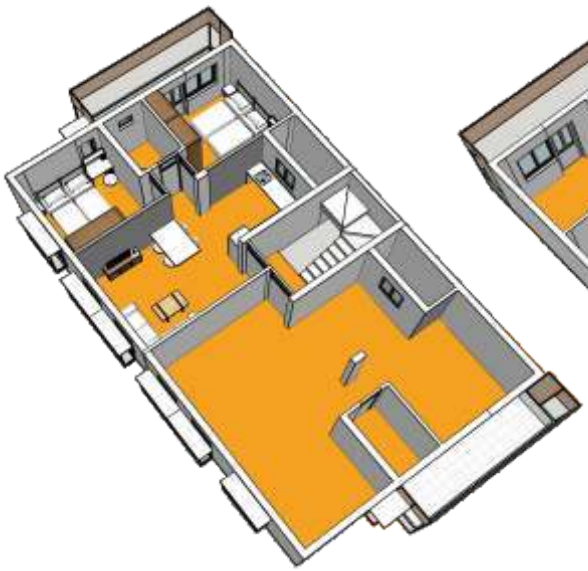


Figure 75.1

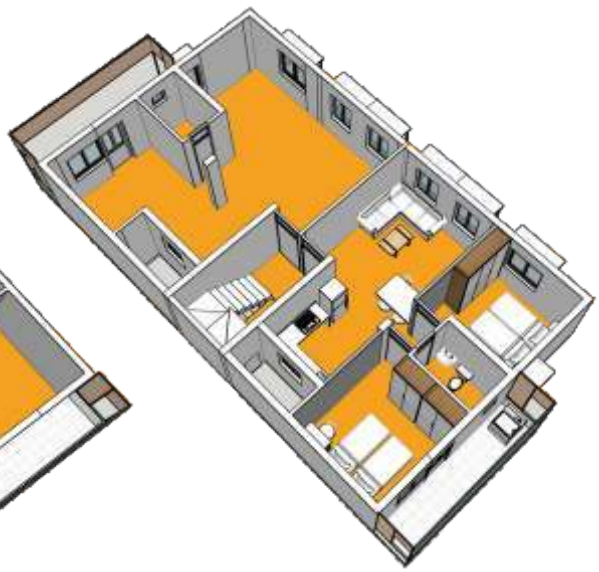


Figure 75.2

Figure 75: *Dwelling unit's interior views type 6*

Figure 76: *Building's Exterior View Type 6*
Source: *Ashok B. Lall Architects*

Type 7 Plot Size: 200 Sq.m. (10m X 20m)

2 Nos. of 2 BHK homes are built on the same floor. Both the units get a street frontage.

Type 7- 2 Nos. of 2BHK Homes

Dwelling Unit Size: 55 Sq. m. Each

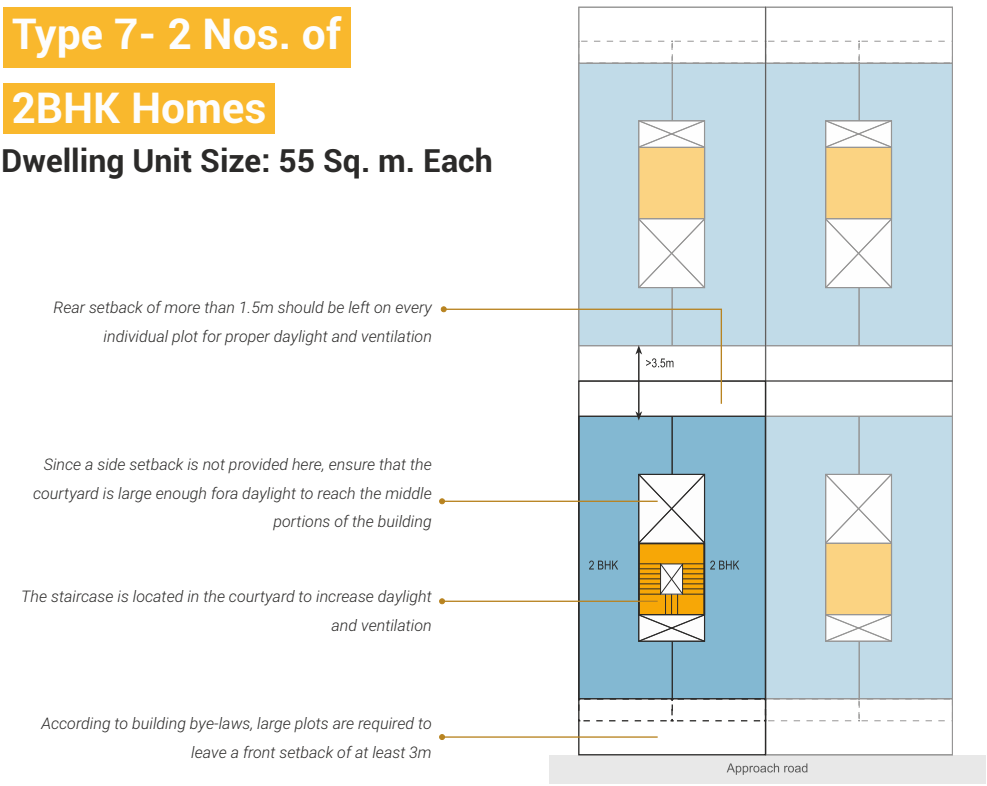


Figure 77: *Type 7*
Source: *Ashok B. Lall Architects*

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

NOTE:

When your plot becomes so large so as to accommodate multiple 2BHK dwelling units, it should have a stilt floor to cater to the increased parking requirement.

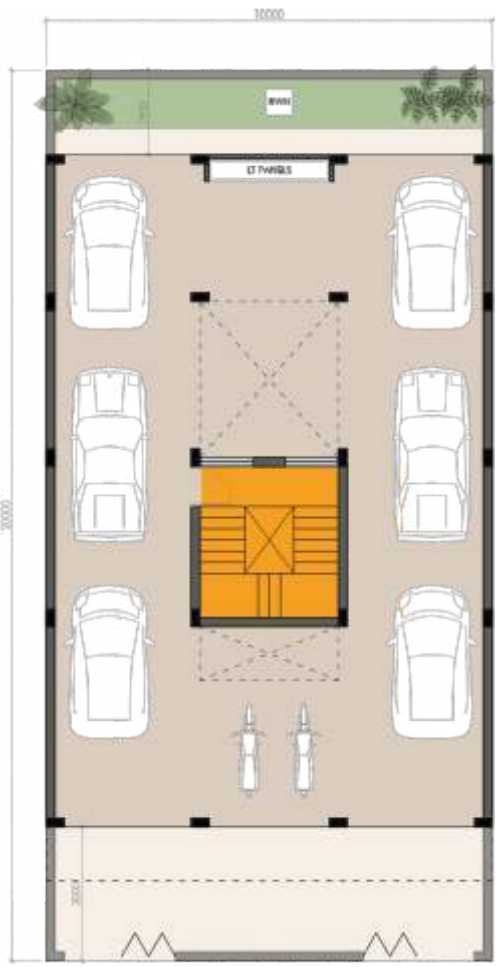


Figure 78: Stilt Floor Plan of Type 7

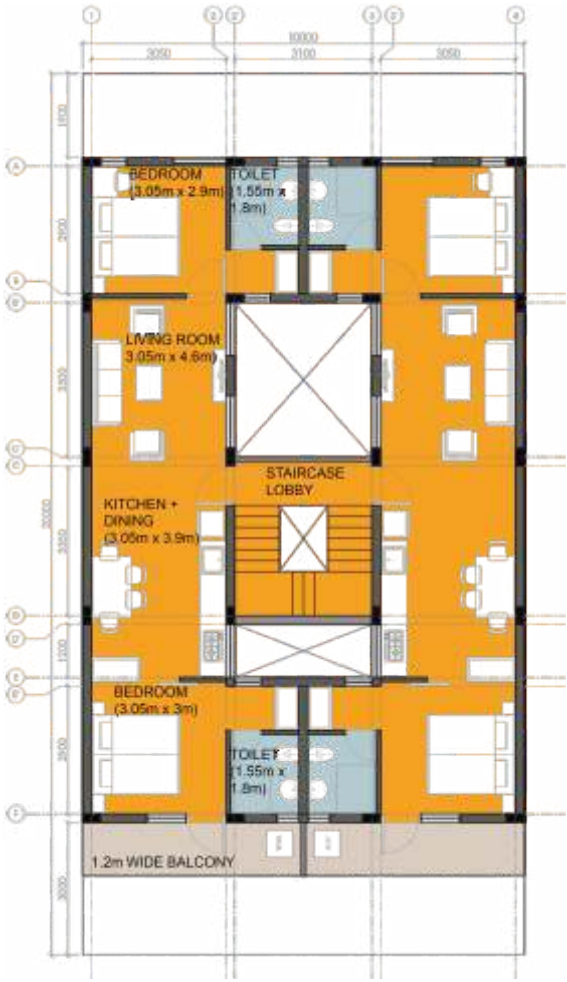


Figure 79: Typical ground floor plan of Type 7 dwelling unit

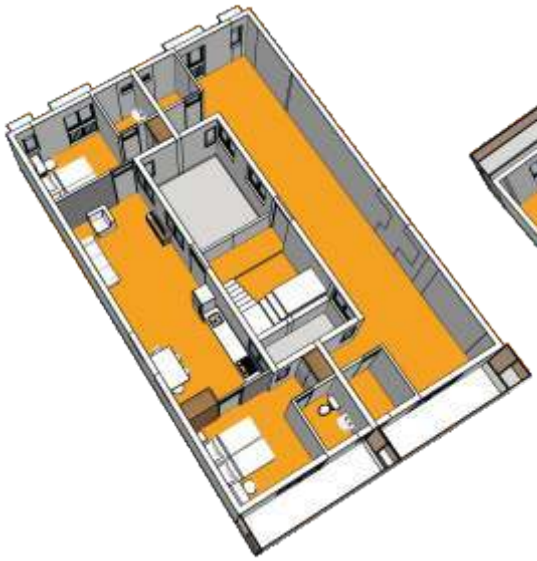


Figure 80.1

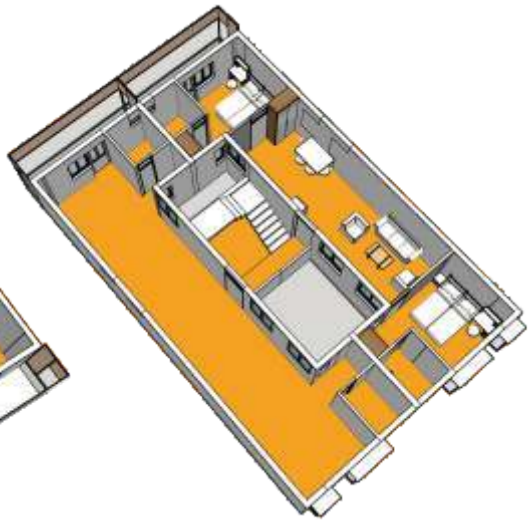


Figure 80.2

Figure 80: *Dwelling unit's interior views type 7*

Figure 81: *Building's Exterior View Type 7*
Source: *Ashok B. Lall Architects*

Type 8 Plot Size: 200 Sq.m. (12.5m X 20m)

When you have a very large plot, different possibilities arise. Here, the same structure on the same plot size can have two configurations. On the same floor, you can either provide 4 Nos. of 1 BHK homes or 2 Nos. of 2 BHK homes. In both cases, half of the units get a street frontage.

Type 8A- 4Nos. of 1BHK Homes

Dwelling Unit Size: 30 Sq. m. Each

Type 8B- 2Nos. of 2BHK Homes

Dwelling Unit Size: 60 Sq. m. Each

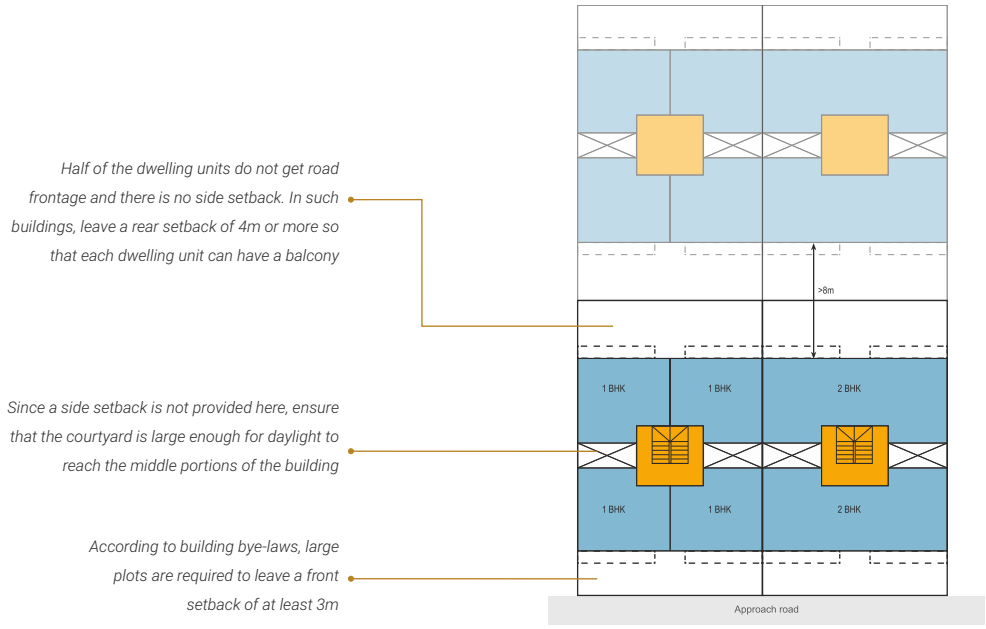


Figure 82: *Type 8A & 8B*

Type 8A- 4 Nos. of 1BHK Homes

Plot Size: 250 Sq.m. (12m X 20m)
Carpet Area: 30 Sq.m. Each

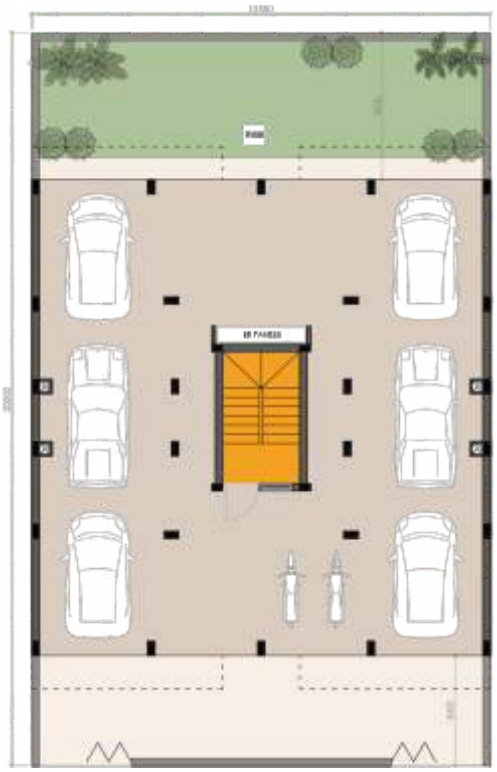


Figure 83: Stilt Floor Plan of Type 8A

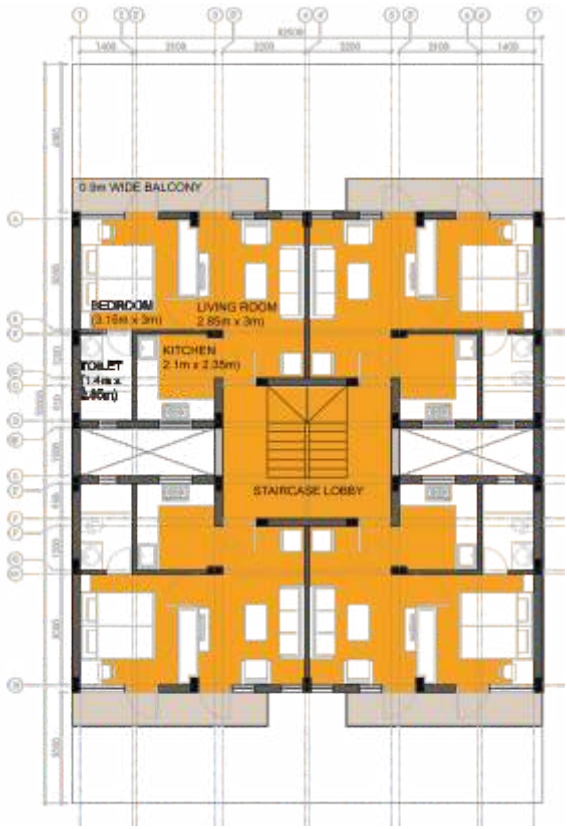


Figure 84: Typical ground floor plan of Type 8A dwelling unit

NOTE:

Here, the same structure on the same plot size can have two configurations. On the same floor, you can either provide 4 Nos. of 1 BHK homes (Type- 8A) or 2 Nos. of 2 BHK homes (Type- 8B). In both cases, half of the units get a street frontage.

Type 8B- 2 Nos. of 2BHK Homes

Plot Size: 250 Sq.m. (12m X 20m)
Carpet Area: 60 Sq.m. Each

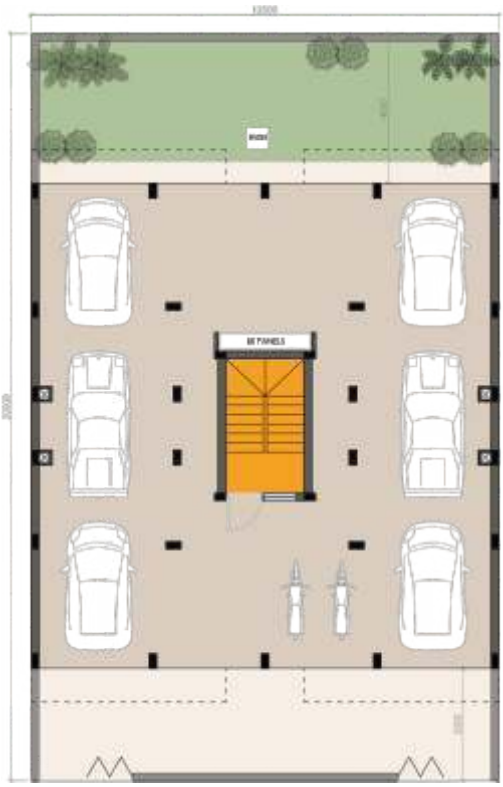


Figure 85: Stilt Floor Plan of Type 8B

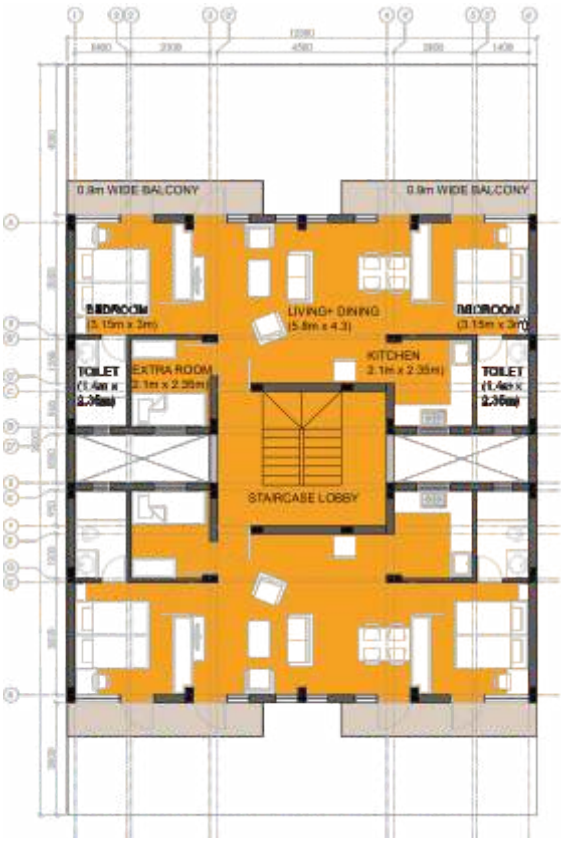


Figure 86: Typical ground floor plan of Type 8B dwelling unit

NOTE:

Here, the same structure on the same plot size can have two configurations. On the same floor, you can either provide 4 Nos. of 1 BHK homes (Type- 8A) or 2 Nos. of 2 BHK homes (Type- 8B). In both cases, half of the units get a street frontage.

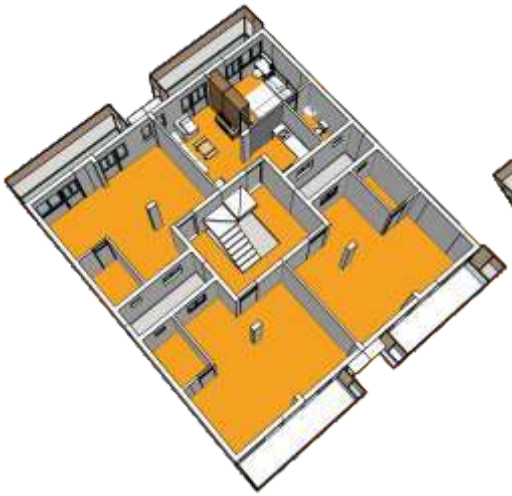


Figure 87: *Dwelling unit's interior views type 8A*

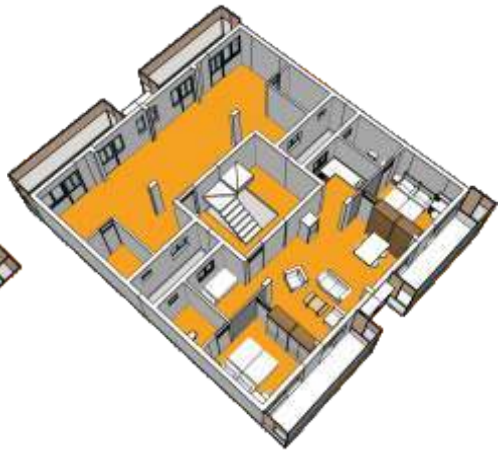


Figure 88: *Dwelling unit's interior views type 8B*

Figure 89: *Building's Exterior View Type 8*
Source: *Ashok B. Lall Architects*

Type 9 Plot Size: 337.5 Sq.m. (12.5m X 27m)

Plots of 300 sq.m. or more can have different combinations of multiple dwelling units on each floor. For instance, you can provide 2 Nos. of 2 BHK homes and 1 No. of 1 BHK home on each floor.

Type 9- 2 Nos. of 2BHK Homes + 1 No. of 1BHK Homes

Size of 2BHK Dwelling Unit: 60 Sq. m. Each
Size of 1BHK Dwelling Unit: 32 Sq. m.

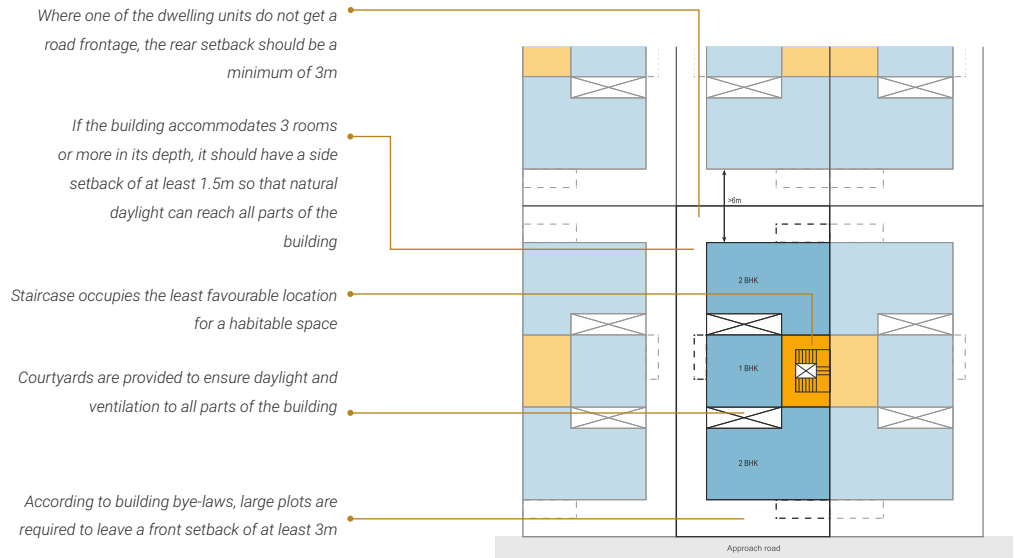


Figure 90: *Type 9*

Legend

- *Staircase*
- *Usable Floor Area*
- *Balcony/ verandah*
- *Open to sky*

TYPE 9- 2 NOS. OF 2BHK HOMES + 1 NO. OF 1BHK HOMES

Plot Size: 337.5 Sq.m. (12.5m X 27m)
Carpet Area of 2BHK Units: 60 Sq.m.
Each Carpet Area of 1BHK Units: 32 Sq.m.

Figure 91: *Stilt Floor Plan of Type 9*

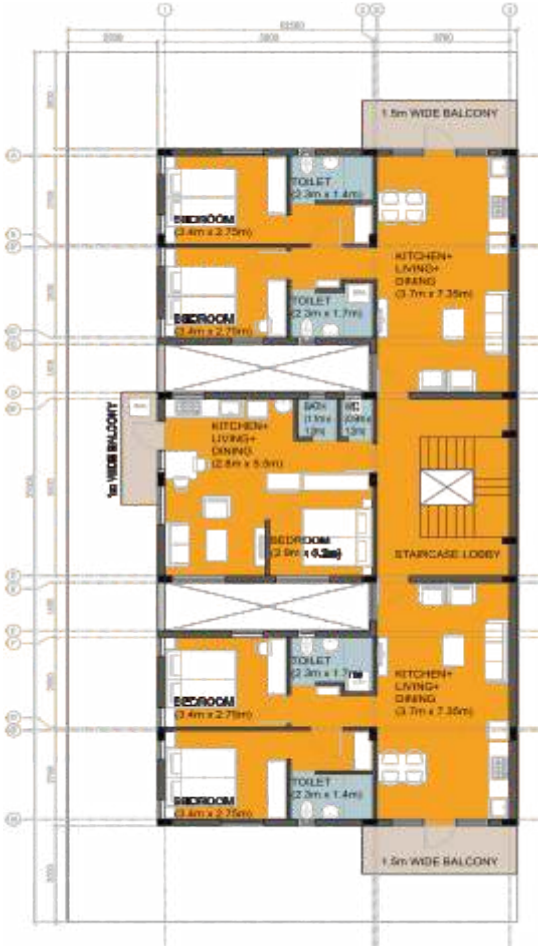


Figure 92: *Typical ground floor plan of Type 9 dwelling unit*

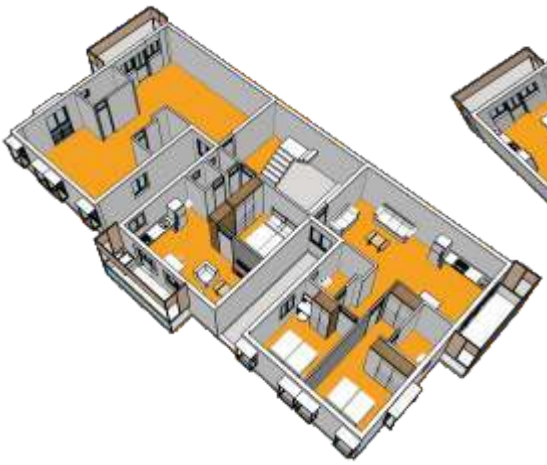


Figure 93.1

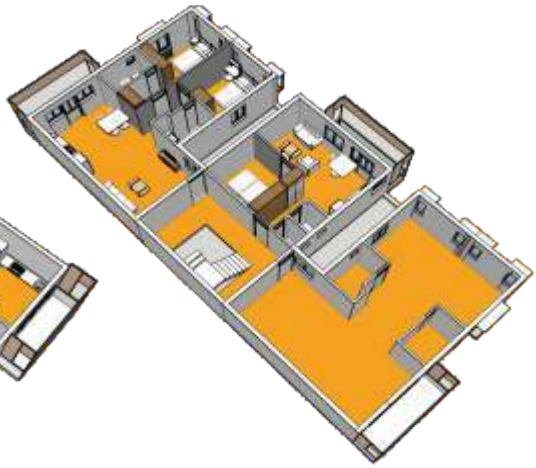


Figure 93.2

Figure 93: *Dwelling unit's interior views type 9*

Figure 94: *Building's Exterior View Type 9*
Source: *Ashok B. Lall Architects*

THERMAL PERFORMANCE OF EACH TYPE DESIGNS

Thermal performance refers to a building's capacity to sustain a comfortable temperature with minimal energy consumption. It plays a crucial role in enhancing a home's energy efficiency, comfort, and overall sustainability. In the following pages, you will find charts for each specific design type, illustrating the thermal comfort hours observed in different climatic conditions. This study considers three distinct climates: warm and humid (Vishakhapatnam, Andhra Pradesh), hot and dry (Gandhinagar, Gujarat), and composite (Indore, Madhya Pradesh). The data presented highlights how each design performs in maintaining thermal comfort across these varying environments, providing valuable insights into their effectiveness in different climatic zones.

The following provides a description of the process used to prepare the simulations.

IIT Bombay has simulated the design combinations to investigate the thermal performance of the architectural drawings and materials. The simulation process includes a typical case (commonly observed across pan-India) and two proposed cases to assess

Months	Vishakaptnam		Indore		Gandhinagar	
	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)
Jan	28.76	23.11	25.72	20.06	26.09	20.43
Feb	29.59	23.93	27.01	21.34	27.56	21.91
Mar	30.81	25.14	29.79	24.13	30.81	25.14
Apr	31.59	25.93	32.30	26.64	32.74	27.08
May	32.32	26.66	33.56	27.90	34.52	28.87
Jun	32.11	26.45	31.50	25.84	33.11	27.45
Jul	31.28	25.62	29.57	23.91	31.63	25.97
Aug	31.25	25.59	29.19	23.54	30.96	25.30
Sep	31.15	25.48	29.44	23.78	31.41	25.75
Oct	31.03	25.37	29.86	24.20	31.16	25.50
Nov	29.94	24.28	28.35	22.69	28.63	22.97
Dec	29.11	23.45	25.94	20.27	26.64	20.99

IMAC temperature range

***IMAC stands for India Model for Adaptive Comfort**

Table 1: *IMAC temperature range*
Source: *IIT Bombay*

the impact on comfort hours. It compares the thermal comfort hours of 3 variations of type design using the IMAC* Model. These three cases (typical case, proposed case 1 and proposed case 2) have been simulated for the nine designs typologies (1: 1A, 1AA, 1B, 1BB; 2: 2A, 2AA, 2B, 2BB; 3: 3,3-3'; 4: 4, 4-4'; 5; 6; 7; 8: 8A, 8B; and 9) and for the three mentioned climatic zones. Different combinations are formed from the design option mentioned in the table. The output observed indicates the discomfort hours as per the ASHRAE 55-2004 and IMAC. **Discomfort hours are calculated based on the simulation results.** The result of the proposed design is compared with the discomfort hours of ambient/ typical case (mentioned below) and the same simulation process are repeated for all the three climatic conditions. The thermal comfort hours are visualized through a heatmap over the months of the year, with a color gradient ranging from red (fewer comfort hours) to green (more comfort hours).

NOTE:

According to the IMAC model, neutral temperature in naturally ventilated buildings varies from 19.6 to 28.5°C for 30-day outdoor running mean air temperatures ranging from 12.5 to 31°C.

Consideration for Simulation

A. Typical Case (Assumption: Commonly observed across Pan-India):

Component	Material	U-value (W/m^2K)
Roof	Cast Concrete (150 mm)	2.652
Exterior Wall	Mud brick block (230 mm) with 12 mm plaster on both sides	1.961
Window	Clear glass 3 mm	5.894
Shading	400 mm overhang on all facades	-
Lighting power density	5 W/m^2	-

Table 2: *Typical Case Assumptions for Simulation Components*

R-factor: SI units: m^2K/W (and IP units: $hr{\cdot}ft^{2}{\cdot}^{\circ}F/Btu$)
U-factor: SI units: W/m^2K (and IP units: $Btu/hr{\cdot}ft^{2}{\cdot}^{\circ}F$)

The window's Solar Heat Gain Coefficient (SHGC) and Visible Light Transmission (VLT) will be 0.86 and 0.89, respectively. The other source of internal heat generation will be neglected for all the different designs. The entrance of all the designs will be assumed to be 0° N.

Source: *IIT Bombay*

B. Design options:

Roof (R)

	Description		U-value (W/m^2K)
R1	Typical Case	Without insulation	2.422
R2	Proposed Option 1& 2	With insulation	1.2

Table 3: *Roof Design Options and U-values*

Exterior Walls (W)

	Description		U-value (W/m^2K)
W1	Typical Case	Burnt Brick	2.128
W2	Proposed Option 1	ACC Brick (200mm)	0.78
W3	Proposed Option 2	Fly Ash Brick (200mm)	1.79

Table 4: *Exterior Wall Design Options and U-values*

Window Walls (Wi)

	Description		U-value (W/m^2K)
Wi1	**Base Building:** 3mm Single Clear Glass	Steel Framing	-
Wi2		Timber framing	-

Table 5: *Window Wall Options and U-values*

Exterior Shading (S)

	Description	Facade
S1	400 mm deep horizontal overhang	All facades
S2	400 mm deep horizontal overhang 400 mm deep horizontal overhang with side fins 400 mm deep horizontal overhang with side fins and front roll-ups	North South East & West

Table 6: *Exterior Shading Options and Facades*

Window Schedule

Description
The opening and closing of the window will be scheduled based on the outdoor temperature. If the outdoor temperature < 30 °C, the window will be open and if the outdoor temperature > 30 °C, the window will be closed.

Table 7: *Window Schedule Based on Temperature*

C. Combinations used for Simulation (3 variations used for different climatic zones):

Component	Base case	Proposed case 1	Proposed case 2
Roof	R1	R2	R2
Exterior Wall	W1	W2	W3
Window	Wi1	Wi2	Wi3
Shading	S1	S2	S2

Table 8: *Simulation Combinations for Different Climatic Zones*
Source: *IIT Bombay*

These three cases were simulated for 9 designs and three mentioned climatic zones. Therefore, 3×9×3 = 81 simulations were performed, and the respective results were generated.

Thermal Performance of Type 1A and 1AA design

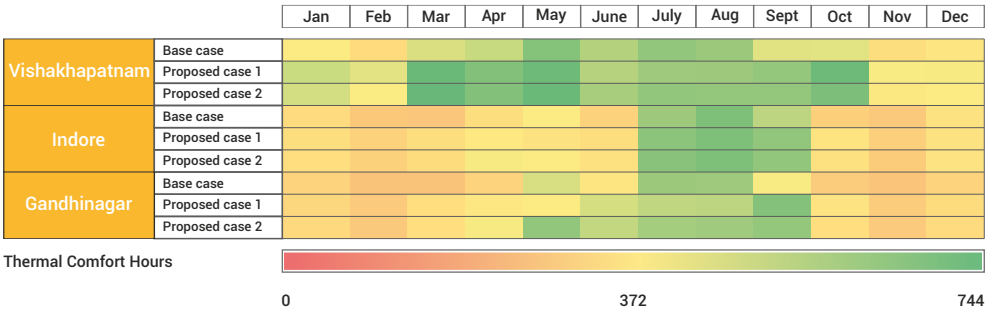


Figure 95: *Thermal Performance of Type 1A and 1AA design*
Source: *IIT Bombay*

The graph shows that Proposed Case 1 (AAC block and roof insulation) outperforms the base case annually in Vishakhapatnam, with more thermal comfort hours in March, April, September, and October. The green zones, indicating higher comfort, are more prominent in summer for this case. Proposed Case 2 (fly ash bricks and roof insulation) performs better in Indore and Gandhinagar, especially in April and May as the thermal mass of fly ash bricks helps adapt to the larger day-night temperature variations in these regions.

Thermal Performance of Type 1B and 1BB design

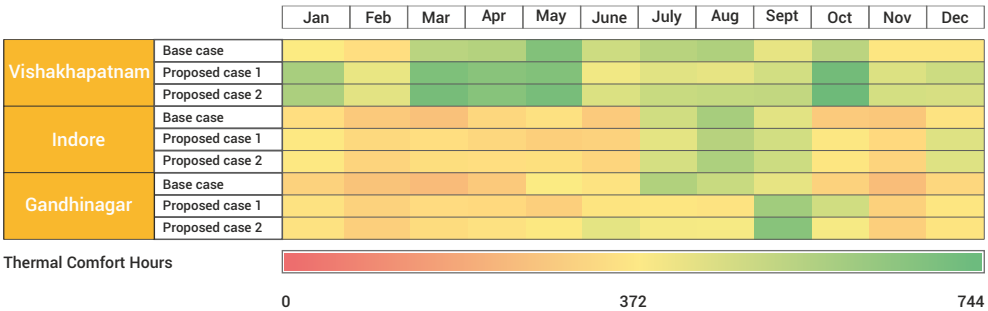


Figure 96: *Thermal Performance of Type 1B and 1BB design*
Source: *IIT Bombay*

For Vishakhapatnam having warm and humid climate, proposed case 2 performs best during the monsoon months (June–September), indicating effective cooling through materials and design. It also outperforms the base case (January–April), making it overall the best option. Similarly, in Indore and Gandhinagar, the base case has lower thermal comfort throughout, with minimal green. Proposed case 2 consistently outperforms both the base case and proposed case 1, especially in summer.

Thermal Performance of Type 2A and 2AA design

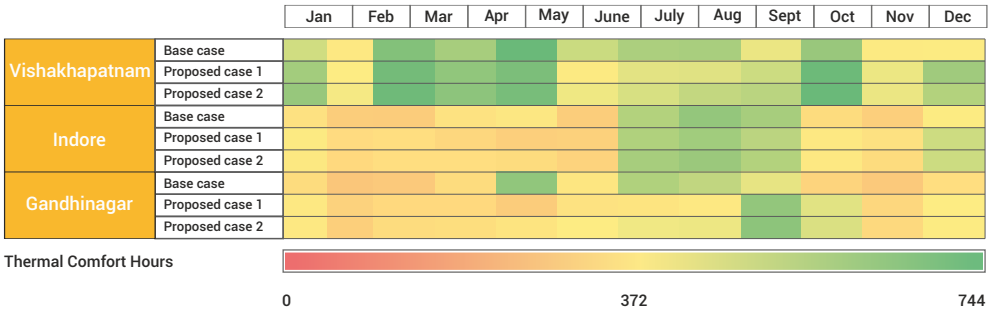


Figure 97: *Thermal Performance of Type 2A and 2AA design*
Source: *IIT Bombay*

In Vishakhapatnam, proposed case 2 performs better in winter (September–December), while the base case excels in summer (June–August). Overall, proposed case 2 outperforms both proposed case 1 and the base case. In Indore and Gandhinagar, proposed case 2 consistently outperforms both the base case and proposed case 1, especially during peak summer (May–July), due to good thermal mass of fly ash bricks that helps in regulating indoor temperatures during day-night fluctuations. Across all locations, proposed case 2 performs best due to its materials (fly ash bricks + insulated roof) and adaptability to different climates.

Thermal Performance of Type 2B and 2BB design

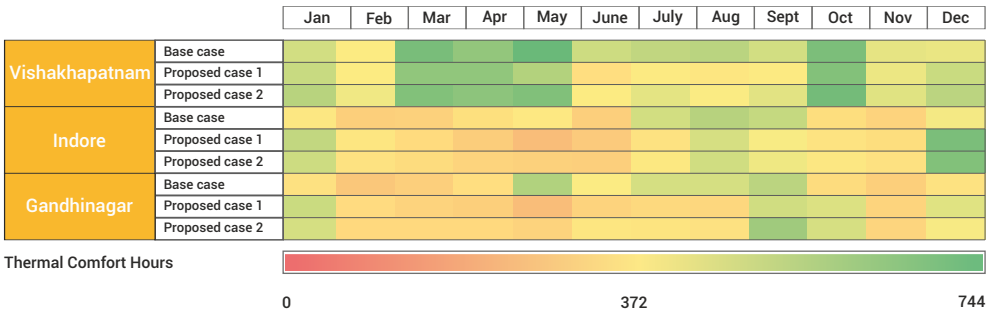


Figure 98: *Thermal Performance of Type 2B and 2BB design*
Source: *IIT Bombay*

In Vishakhapatnam, the base case outperforms both proposed case 1 and case 2. The use of red burnt bricks and an uninsulated roof in the base case allows better ventilation, helping to regulate indoor temperatures more closely with the outdoor comfort zone. In Indore and Gandhinagar, proposed case 2 performs better overall in annual thermal comfort hours, though the base case performs better during the summer months in both locations.

Thermal Performance of Type 3 and 3-3' design

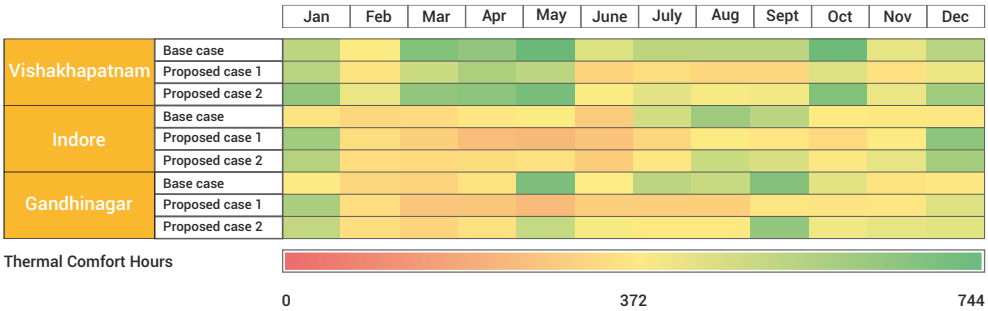


Figure 99: *Thermal Performance of Type 3 and 3-3' design*
Source: *IIT Bombay*

In Vishakhapatnam, the base case performs better during the monsoon (June–August) due to natural ventilation and lack of insulation, offering more comfort hours than proposed case 1, which is better for the rest of the year, especially in summer and cooler months. In Indore, proposed case 1 is worst annually but improves over the base case in cooler months, while proposed case 2 performs best year-round, especially in summer. The difference in annual comfort hours between the base case and proposed case 2 is minimal. In Gandhinagar, the base case outperforms both proposed cases, showing that red burnt bricks without insulation are more effective than insulated fly ash or AAC bricks.

Thermal Performance of Type 4 and 4-4' design

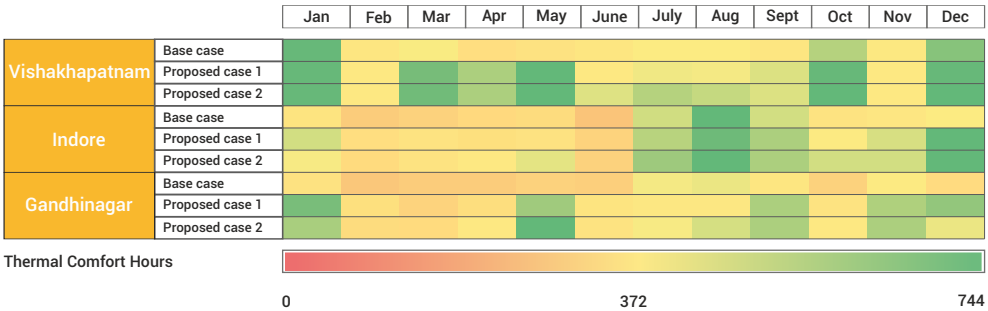


Figure 100: *Thermal Performance of Type 4 and 4-4' design*
Source: *IIT Bombay*

In Vishakhapatnam, proposed case 2 (fly ash brick with roof insulation) outperforms other cases, maintaining high thermal comfort year-round, allowing occupants to avoid air conditioning with adaptive practices. In Indore, proposed cases 1 and 2 perform similarly in monsoon and winter (July–December), while case 2 excels in summer (Apr–May), resulting in the highest annual thermal comfort hours. In Gandhinagar, the base case performs poorly due to low thermal performance and the courtyard allowing hot air in. Proposed case 2 improves summer comfort with fly ash bricks, leading to higher annual comfort hours.

Thermal Performance of Type 5 design

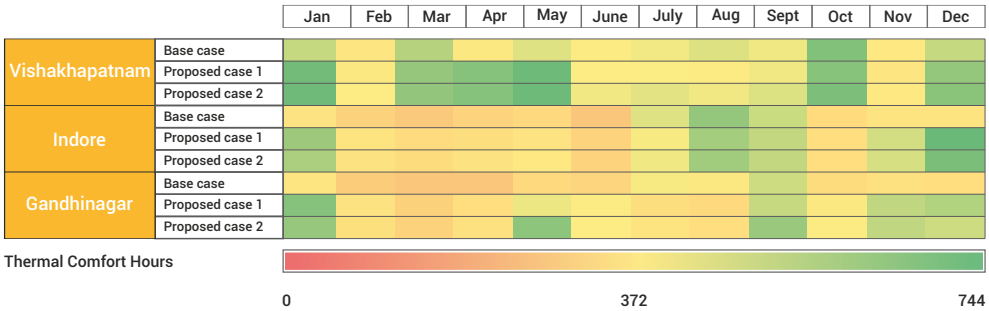


Figure 101: *Thermal Performance of Type 5 design*
Source: *IIT Bombay*

The proposed case 1 and 2 have almost the same thermal comfort hours except in monsoon months (June–Sept) which leads to higher annual thermal comfort hours of proposed case 2 for Vishakhapatnam. Similar trends have been observed for Indore and Gandhinagar. Using fly ash brick with insulation on roof, the HVAC system can be avoided for Vishakhapatnam.

Thermal Performance of Type 6 design

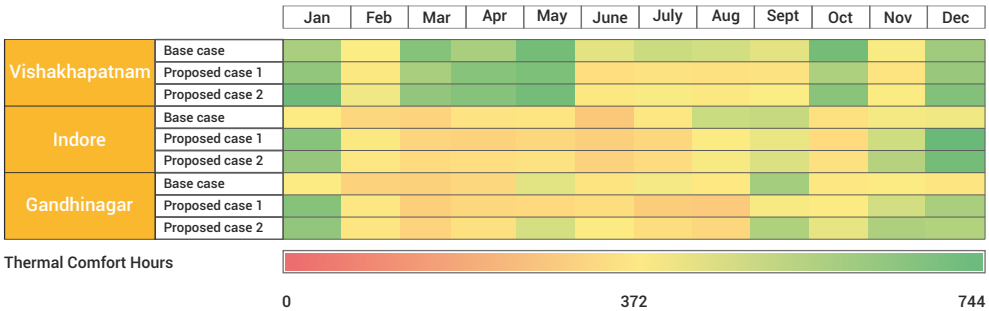


Figure 102: *Thermal Performance of Type 6 design*
Source: *IIT Bombay*

In Vishakhapatnam, the base case offers good thermal comfort during the monsoon (June–August) due to natural ventilation and humidity dampening effect but faces discomfort in summer due to heat gain from uninsulated roofs and red bricks. Proposed case 1 underperforms in the monsoon due to reduced ventilation. In Indore, the base case performs poorly in summer but offers moderate comfort in cooler months. Proposed case 2 (fly ash bricks with insulated roofs) performs better in summer and shows similar results in Gandhinagar, providing the highest thermal comfort in both Indore and Gandhinagar.

Thermal Performance of Type 7 design

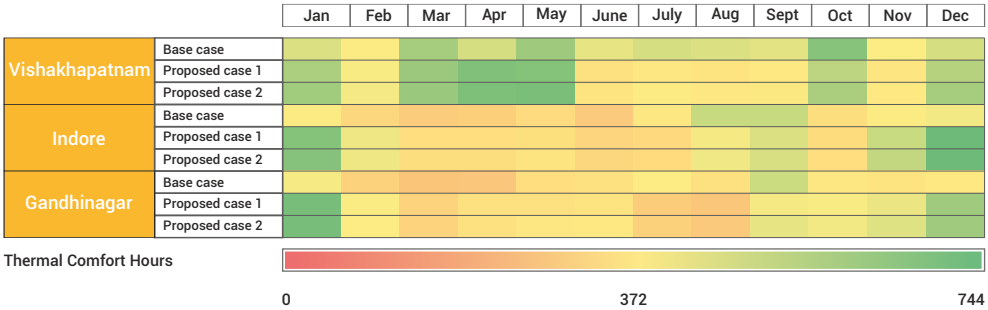


Figure 103: *Thermal Performance of Type 7 design*
Source: *IIT Bombay*

The base case performs well in Vishakhapatnam due to natural ventilation and minimal insulation needs in the hot and humid climate. However, lack of insulation causes some discomfort in summer (April-June). Proposed case 2, using fly ash bricks with roof insulation and overhangs, provides the best comfort in summer. In Indore and Gandhinagar, case 2 offers the highest thermal comfort year-round, except during the monsoon months (July–September).

Thermal Performance of Type 8A, 8B and 9 design

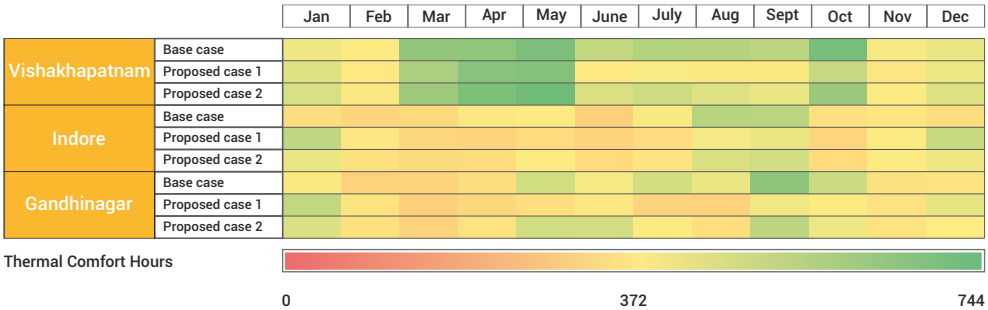


Figure 104: *Thermal Performance of Type 8A, 8B and 9 design*
Source: *IIT Bombay*

In Vishakhapatnam, the base case (brick wall with no insulation) performs best as it provides the highest thermal comfort year-round due to better air circulation from courtyard and improved ventilation. In Indore, the base case and proposed case 2 show little difference, with case 2 slightly outperforming in winter (November–January). In Gandhinagar, the base case outperforms during the monsoon (July–Oct), but case 2 (fly ash brick with roof insulation) is a strong alternative for modern comfort.

PARAMETERS/CHECKLIST/ RATING FOR ENSURING SUSTAINABILITY AND THERMAL COMFORT

Based on the above simulation on the type designs, the following parameters have been shortlisted, for inclusion into the construction and design. By ensuring your home follows the below checklist, you can ensure that your home is sustainable, environmentally conscious and eligible for **'Green Certification'.**

Component	Essential	Recommended	Good to have
Design Consideration	All rooms, toilets & kitchen get naturally day lit and ventilated	Light colored external paint	North-south orientation of main building facade
	Cross ventilation for all rooms	Independent access to staircase	
	Window sizing and placement for adequate natural daylight in all rooms	Having verandah/balcony as buffer zone.	
	External shading systems for windows and balconies according to orientation		
Reduction in carbon footprint	Insulation in roofing to get roof u-value to be less than 0.65.	Wooden doors and windows	
	Reflective roof finish		

Table 9: *Parameters for ensuring sustainability & thermal comfort*

Quiz Time!

1. What should be the preferred building orientation for your house given that there is room for flexibility?

   a North-South
   b East-West
   c North east- South west
   d None of the above

2. According to the statement, "A good structural engineer will design the most economical foundation and structure. A good design will not use more than ____ kg of reinforcement steel per sqm. of gross built-up area." Fill in the blank.

   a 28 Kg
   b 35 Kg
   c 50 Kg
   d 70 Kg

GLOSSARY

Building Typologies	Categories or classifications of buildings based on their design, structure, and function. Examples include multi-story structures and single-floor homes.
Design Principles	Fundamental guidelines or concepts used in the planning and creation of structures, focusing on aspects such as aesthetics, functionality, sustainability, and efficiency.
Passive Design Strategies	Design techniques that optimize the use of natural resources like sunlight, airflow, and thermal properties to maintain comfortable indoor conditions, thereby reducing dependence on artificial energy systems like heating and cooling.
Natural Light Optimization	The practice of designing spaces to make the most effective use of sunlight, reducing the need for artificial lighting during the day.
Airflow Optimization	Strategies to enhance natural ventilation in a building, ensuring fresh air circulation and reducing the need for mechanical ventilation systems.
Energy-Efficient	Referring to designs, systems, or practices that use minimal energy to perform efficiently, reducing energy waste and consumption.
Building Simulation	A computational method used to model and analyse the thermal performance of architectural designs and materials under different climatic condition.
ASHRAE Standards & Guidelines	A standard developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, which provides guidelines for designing and operating HVAC systems, Indoor air quality and energy efficiency.
IMAC (India Model for Adaptive Comfort)	A thermal comfort model tailored to Indian climatic conditions, accounting for how people adapt to varying temperatures.
Solar Radiation	Energy emitted by the sun, which affects building temperature and energy performance.
Solar path	The trajectory the sun appears to take across the sky, influencing light and heat distribution in buildings.
High Angle Sun	The sun's position when it is directly overhead, typically in summer, affecting shading requirements.
Low Angle Sun	The sun's position near the horizon, typically in winter, allowing deeper sunlight

	penetration into interiors.
Structural Engineer	A specialized engineer who ensures the structural safety and stability of a building by designing foundations and structures that can withstand loads and stresses.
Reinforcement Steel	Steel bars or mesh used in concrete structures to provide strength and support, measured in kilograms per square meter (kg/sqm) of the gross built-up area.
Gross Built-Up Area	The total area of a building, including all floors, walls, and structural components, measured in square meters.
Gravel Flooring	A type of flooring made from loose, small stones (gravel) that provides natural drainage and a rustic aesthetic, commonly used in courtyards and outdoor spaces.
Bubble Deck Roof	A lightweight structural system for concrete slabs that incorporates hollow plastic spheres to reduce the amount of concrete required, improving efficiency and sustainability while maintaining strength.
CSEB Blocks (Compressed Stabilized Earth Blocks)	Environmentally friendly building blocks made from a mix of soil, sand, cement, and water, compressed to create durable and sustainable construction materials.
Sun Scoop	A passive architectural feature designed to capture and direct sunlight into a building, often to improve natural lighting and ventilation in interior spaces.

CASE STUDY

BUTTERFLIES

Jaunapur, New Delhi

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BUTTERFLIES JAUNAPUR, NEW DELHI

Figure 105: *Front Facade*

The Butterflies building was designed by Architect Ashok B Lall. The building uses passive design techniques to lower its energy consumption and carbon emissions.

Figure 106: *Self-shading windows*

Figure 82: *Climatic Zone Map of India*

Location

The site is situated in the southern part of Delhi, in the urban village of Jaunapur, which is characterized by narrow streets and small plot sizes. Jaunapur is a part of the administrative area of the South Delhi district and is situated near popular areas like Mehrauli and Vasant Kunj. The area falls under the Composite climate zone, posing significant challenges for architects in designing buildings that are well-suited to the local climate.

Figure 107: *Jaunapur Location*
Source: *Google Maps*

Building Orientation & Site Constraints

- The Plot did not give the architect a lot of flexibility in terms of the orientation of the built mass
- It also had a sharing walls with the neighboring buildings on 3 out of the 4 edges
- The plot is a narrow strip of land surrounded by buildings on 3 out of 4 edges

Figure 108: *Building Orientation*
Source: *Google Maps*

Courtyards

What?	Why?
• The Courtyards are vertical cores in a building	• Courtyards are used for natural ventilation of light and air • In a densely built up building, distributing small courtyards provides light and ventilation

"There are no complaints of flooding during the rainy season as the courtyard floor absorbs all the rainwater." **Mr. Auli**

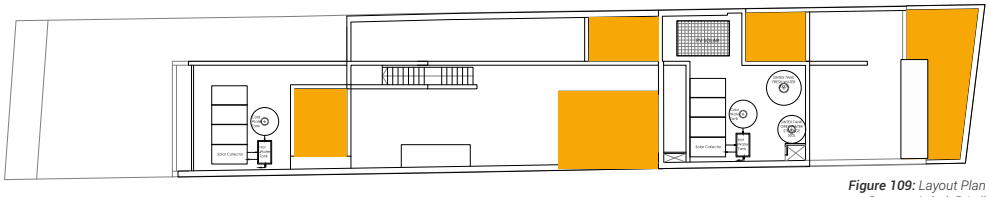


Figure 109: *Layout Plan*
Source: *Ashok B Lall*

Figure 110: *Gravel Flooring*

The Gravel flooring of the courtyards help in absorbing the rainwater. This helps in recharging the ground water level and prevents the basement from flooding.

Figure 111.1

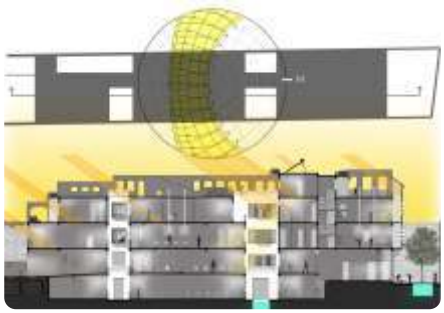


Figure 111.2
Figure 111: *Sunlight Penetration*

The diagram above shows how the courtyards helps the sunlight to seep into the building.

White Roofing Tiles

Figure 112: White reflective roofing tiles

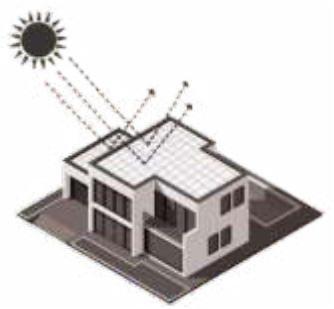


Figure 113: Reflective roofing

What?	Why?
• White coloured tiles with a reflective finish	• Reflects 70% of the heat from direct radiation from the sun. This keeps the floor below the roof cooler

Building Material, Elements, Cost & Techniques

Figure 114: Bubble Roof Deck
Source: Ashok B. Lall Architects

1. Roofing

Bubble Deck Roof

What?	How?	Why?
• A technique used during the casting of the floor slabs	• Plastic balls are tied to the reinforcement • The concrete is poured after these balls are securely tied to the reinforcement	• This technique helps in reducing the weight of the slab hence causing an overall reduction in the usage of steel

Savings	
Concrete	**20%** for 4.5m and wider spans
Steel	**20%** for 4.5m and wider spans
Cost	Approx **₹150/sqm** of floor slab area

Table 10: *Cost Savings*
Source: *Ashok B Lall Architects*

Embodied energy is reduced by approx. 115MJ per sq.m. of the floor area.

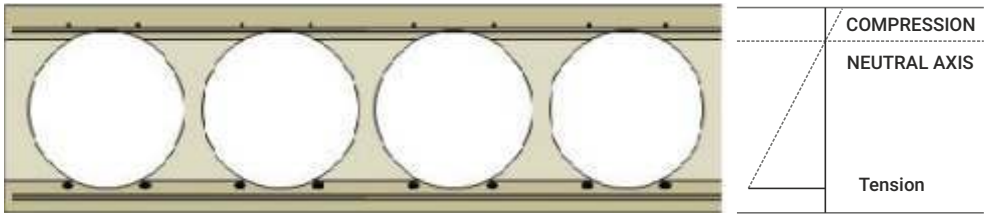


Figure 115: *Tension Diagram for Bubble Slab*

Challenges Faced

1. Manufacturing/procurement related

- The balls which were used in the slabs were manufactured on a specially for the building
- In order to accommodate the dimensions of the slab, balls of a certain size were specially manufactured on order

2. Construction related

- The spacing of reinforcement bars has to be according to the diameter of the balls

2. Walls

CSEB Blocks

Approximately 75,000 CSEB blocks were made. Bricks recovered from the demolition of an old workshop that existed on site were also utilised.

What?	How?	Why?
• Compressed Stabilized Earth Blocks are made from local soil mixed with cement sand and water • Sun dried, not burnt in kilns	• Soil from the excavation of the basement is collected • This soil is then mixed with cement, sand & water • This mixture is then compressed into blocks using a pressing machine	• CSEB has a low embodied energy hence making it environment friendly • These blocks are generally more cost effective when compared with red bricks • CSEB Stabilized earth mortar is 30% cheaper than cement sand mortar

Source: *Auroville Earth Institute*

Figure 116.1
Source: *Adobe Stock Image*

Figure 116.2

Figure 116: *CSEB Blocks*
Surce: *Freepik*

- Depending on the workmanship and quality, CSEB Blocks do not necessitate the use of plaster, especially for the interiors. It saves the material and cost that goes into plastering
- To protect from rain however, they may be plastered on the external facades

Challenges Faced

- The use of a silicone sealant is suggested as a protective coating on the exposed faces of these blocks
- It is up to the homeowner to weigh his choices and decide whether he/she is willing to spend extra to achieve their aspired wall finishes or if they rather chose to save money and go for a raw wall finish, which is completely acceptable
- A designated space has to be assigned for the production of CSEB
- Quality control is important while making CSEB considering its maximum strength can go up to 5mpa

3. Windows

Self Shading Mechanism

"The Fins are kept closed during the summer months, this helps to keep the room cooler to an extent.

In winter months we like to keep them open, the sunlight enters and makes the room a comfortable place to sit and work. Apart from this the shading device doesn't require any complex maintenance, it is an independent mechanism." –

Auli, Resident of the Building

Figure 117: *Fins*

What?	Why?
• Vertical/Horizontal fins outside the window installed to provide extra layer of shading	• To stop direct harsh sunlight from entering the building • Aesthetic element

Figure 118.1

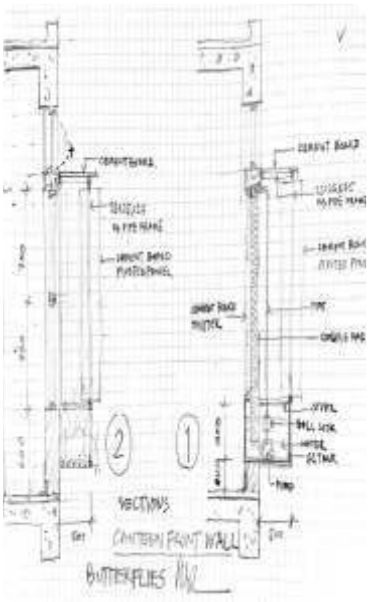


Figure 118.2

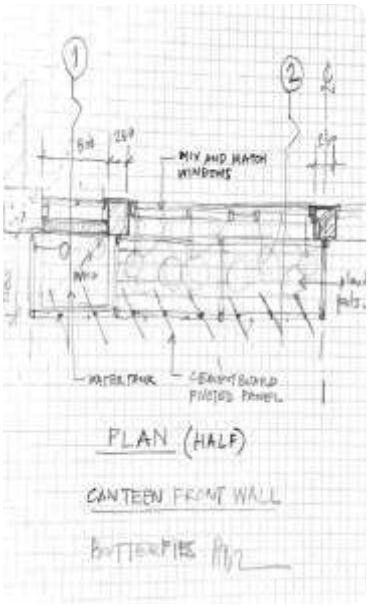


Figure 118.3

Figure 118: *Key plan & Section of the Front Wall*
Source: *Ashok B. Lall Architects*

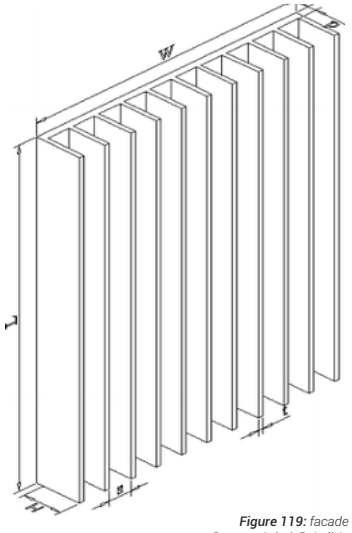


Figure 119: *facade system*
Source: *Ashok B. Lall Architects*

- The external shading panels are pivoted frames fixed into a steel pipe framework fixed to the wall

Figure 120: *Window with the shades closed*

Figure 121: *Window with the shades partially open*

Stone Overhangs

What?	Why?
• Stone Lintels have been used as a shading device for windows	• Helped in reducing the cost and time of labor and concrete used for construction

Figure 122.1

Figure 122.2

Figure 122: *Stone overhang*

Recycled Windows & Doors

Discarded doors and windows were hand-picked and recycled for installation in the building. This helped in reducing the overall cost of the building.

Figure 123.1

Figure 123.2

Figure 123.3

Figure 123: *Recycled windows*

Sun Scoop

What?	Why?
• Glazed scoop to catch the winter sun in the northern rooms	• The light entering the room through the sun scoop gets diffused • The diffuse light is less harsh compared to direct sunlight coming from other openings. • North remains dark otherwise

Figure 124.1

Figure 124.2

Figure 124: *Glazed Scoop*

Services and Equipments

1. Solar Water Heating System

Energy Savings	2500 KWh/year
Setup Cost	`45,000

Figure 125: *Solar Water Heating System*

What?	How?	Why?
• Water heating system which uses solar energy to heat water	• The sun's thermal energy heats the fluid in the solar collectors • Then, this fluid passes through a heat exchanger in the storage tank, transferring the heat to the water	• 70-80% of energy consumption by water heating can be reduced if the generic water heater is replaced by solar water heaters

Sl No.	Capacity of the System	Flat Plate Collector based system (In ₹)	Evacuated Tube Collector based system (In₹)
1	100 liters per day (lpd)	24000	17000
2	200 lpd	39000	30000
3	300 lpd	55600	44000
4	400 lpd	69312	56000
5	500 lpd	88000	70000

Table 11: *Cost Comparison of Solar Water Heating Systems Based on Capacity*
Source: *Ministry of New & Renewable Energy*

The Building uses **two 200 lpd Flat plate Collectror based system.**

2. Solar Power System

What?	Why?
• A system which converts energy from sun into electricity using a Photovoltaic panel	• Solar power system is a eco friendly and cost effective system of producing energy. • It helps in reducing the monthly electricity bill

Figure 126.1

Figure 126.2:

Figure 126: *Solar Power System*

Capacity	4.5 Kwh
Energy Production	6900 Kwh

Setup Cost	₹2,50,000
Cost Savings	₹55,200 (if electricity tariff is ₹8/KWh)

3. Evaporative Cooling System

What?	How?	Why?
• A Passive Cooling system which consumes 10% of the energy that is needed for mechanical cooling while delivering more or less equal temperatures as traditional mechanical cooling systems	• Hot outside air is forced through wet cooling pads by means of a motor-driven fan • The cooling pads are moistened continuously by a water pump that delivers water to the cooling pads • The cooled down air is then pulled using exhaust fans	• The out-coming air can then be cooled down between 60 and 90% of the wet-bulb depending on the effectiveness of the evaporative media • Evaporative cooling is only affective when the atmosphere is **hot and dry** • It shouldn't be used in humid climate

Figure 127.1

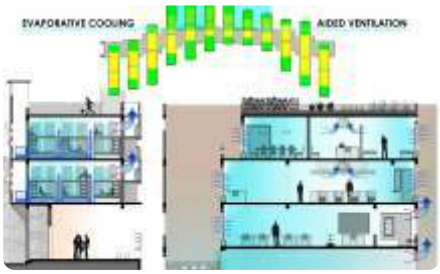


Figure 127.2

Figure 127.3

Figure 127: *Evaporative Cooling System*
Source: *Ashok B. Lall Architects*

Install a large cooling pad on one side of the room. Fix an exhaust fan on the opposite side of the room. Close all windows, switch on the exhaust fan.

MODULE II

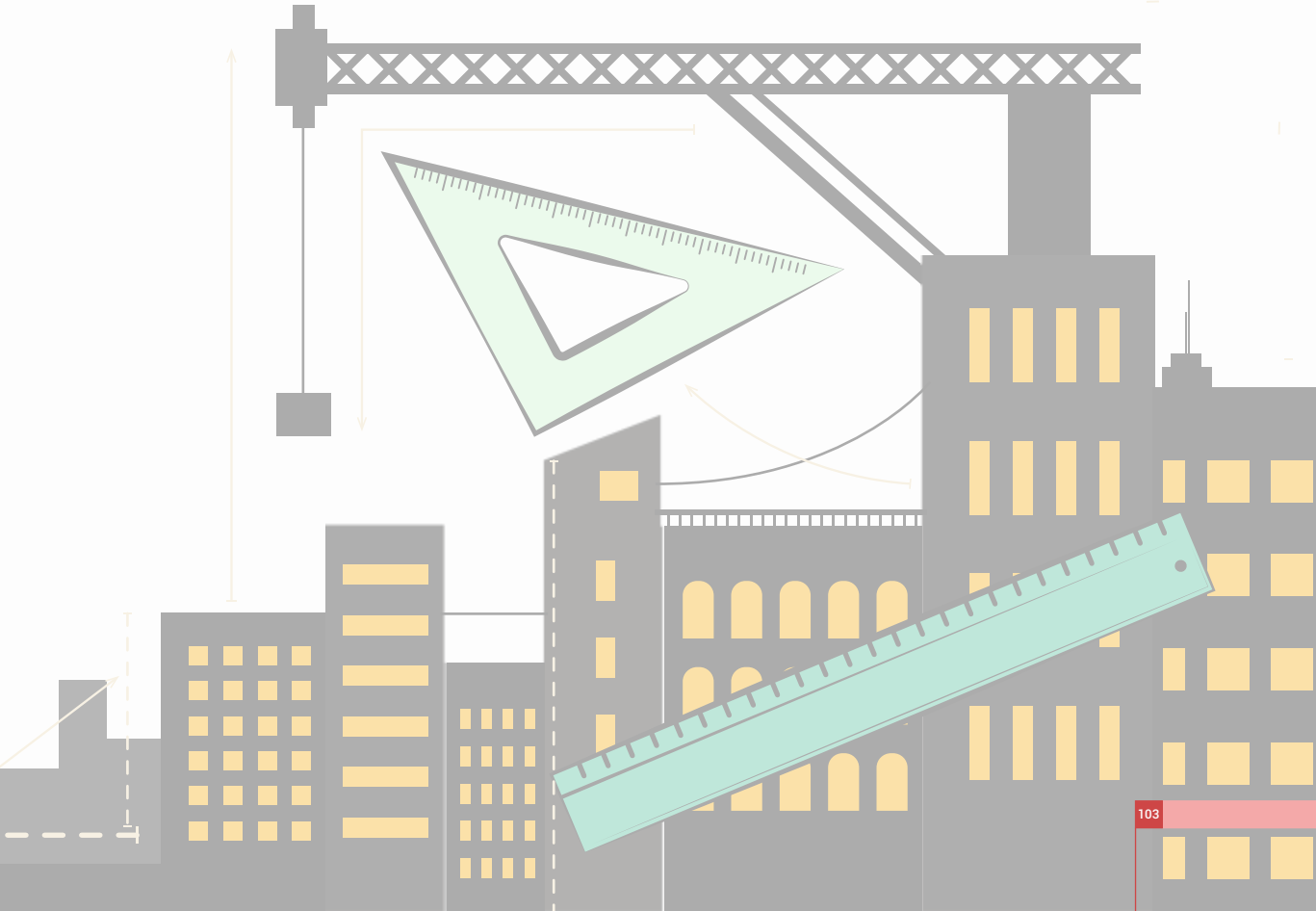
MATERIALS, CONSTRUCTION TECHNIQUES AND ELEMENTS

This module explores sustainable construction techniques and materials used to minimize the environmental impact of building structures.

TABLE OF CONTENTS

IN THIS MODULE...

...you will explore a variety of building materials and alternative construction techniques that can be applied to your home's superstructure, with a particular focus on roofs, walls, and essential elements like doors and windows. This module will provide you with the knowledge to select the most sustainable and cost-effective materials, while also ensuring that your home is durable and energy-efficient.You will learn about eco-friendly building options, such as natural insulation materials, reclaimed wood, and sustainable bricks, that can help reduce environmental impact without compromising structural integrity. The module also delves into innovative construction techniques, such as modular building methods and green roofing systems, that improve efficiency and minimize waste. With easy-to-follow, visual step-by-step guides, this module will empower you to make informed decisions when constructing or renovating your own home. By the end of this module, you will be equipped with practical insights to integrate sustainable materials and techniques, ensuring your home is built to last while minimizing its ecological footprint.



WHY DO WE NEED TO CHANGE THE WAY WE BUILD?

Building homes the way we currently do harms the environment and contributes to climate change, especially as more people move from rural areas to cities and need solid, permanent houses. While nature offers many materials, processing them often relies on coal and gas, releasing harmful gases that cause serious issues like floods and rising temperatures.

By adopting environmentally sustainable construction methods and choosing sustainable materials, we can create healthier homes that use less energy and water. This module aims to provide the tools and guidance needed to build better and more sustainably.

By changing our building practices, we can create healthier living spaces, reduce our carbon footprint, and ensure a sustainable future for our planet. We need to reconsider our choice of materials, construction methods, and energy sources. This means using sustainable, natural materials, minimizing waste, and designing homes that require less energy for heating and cooling. Prioritizing eco-friendly options in every step of the building process is essential.

Today, we've lost sight of how to build comfortable homes that don't consume excessive electricity. The good news is that people around the world are beginning to explore new, environmentally friendly building methods. Let's work together to create sustainable homes that rely less on electricity, conserve water, and protect our environment.

To make these changes, we can start by researching and adopting green building practices, utilizing renewable resources, and implementing energy-efficient designs. Collaborating with builders, contractors and architects who focus on sustainability is crucial. Additionally, educating ourselves and our communities about the benefits of sustainable building can help drive this change forward. This module aims to provide the guidance and tools needed to build better and more sustainably using resource-efficient practices in construction.

Come, join hands to make our homes sustainable, so that we depend less on electricity for our comfort, use water carefully and build in ways that will not upset our Environment!

WHAT DO WE NEED TO CHANGE?

To know what we really need to change in the way we build currently, we need to first understand what components of a building are major contributors towards our degrading environment.

Some Key Concepts

Embodied energy

is the total energy spent in the processing and production of a material.

Operational energy

refers to the energy spent to run the building during its occupancy. It includes water heating, space cooling, lighting, home appliances, etc.

Building Components By Percentage Distribution

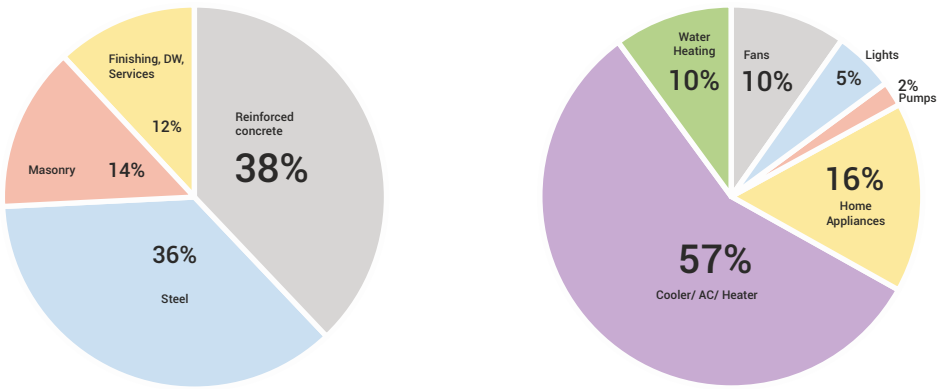


Figure 128: *Building Components By Percentage Distribution*
Source: *Ashok B. Lall Architects*
This data is based on the quantities derived for an affordable group housing project in Palghar, Maharashtra.

NOTE

It is important to note here that the Door Window (DW) Embodied energy Component is quite low. It is because 'timber' has been used here. Other materials for doors and windows can lead to high embodied energy impact.

Inferences

The above graphs shows the various contributors to operational energy and embodied energy in a typical building, throughout its lifespan.

While it displays the percentage distribution and share of various building components and their contributions to GHG emissions, the observations and conclusions are outlined below.

OBSERVATIONS	CONCLUSIONS
Despite its small mass, steel significantly impacts a building's embodied energy.	Even a small reduction in steel usage can lead to significant cost and embodied energy savings.
Reinforced concrete is the largest contributor to embodied energy.	Optimizing structural design to reduce concrete volume also saves on costs and embodied energy.
Masonry also plays a significant role in increasing embodied energy.	The choice of walling material greatly impacts a building's embodied energy.
Space heating and cooling systems (ACs, coolers, heaters) consume the most energy in homes.	Reducing space heating and cooling needs is essential for lowering operational energy in homes.
Home appliances and water heating also contribute substantially to energy consumption	Using efficient fixtures and appliances can lead to substantial energy savings.

Did You Know?

Building materials also have an impact on its operational energy.

For example, the roof of a building is where most of the heat transfer takes place. In hot climate, this leads to an overheated indoor environment that requires active cooling systems.

Thus, more the amount of heat gained through the roof, more is the building's cooling demand and more is its operational energy.

Likewise, the entire building envelope determines the building's operational energy, based on the insulating properties of its Materials.

Both, embodied energy as well as operational energy can be reduced without increase in cost by the home's planning/designing and the construction techniques and materials used to build them.

The following sections look at these various alternative construction techniques and materials.

HOW DO WE CHANGE THE WAY WE BUILD?

Structure

The structural systems recommended here offer a reduction in the requirement of reinforcement steel while integrating lightweight block elements that reduce the thermal conductivity of the floor slab, which is particularly beneficial for the roof slab.

NOTES:

1. Ensure that the foundation and the supporting structure that is built initially allows for the additional floors that may be built later.
2. Provided here, are only conceptual recommendations. Consult a structural engineer for detailed design and dimensioning of the structural members of the building.

Pre-cast T beam and Hollow Block

A T-beam is a load-bearing structure with a T-shaped cross section that is used in construction. The horizontal top of the T is called the flange, and the vertical stem is called the web. T-beams are used in the roof structures of both commercial and private buildings.

In the recommended case, The T beams are prefabricated at the site and placed on the walls. Hollow concrete/ clay blocks are placed between the beams.

A thin layer of lightly reinforced concrete is cast on top. The hollow blocks reduce the thermal conductivity of the slab. No formwork is required.

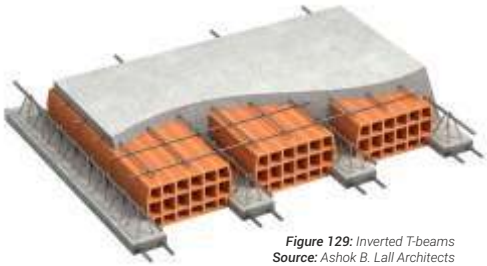


Figure 129: *Inverted T-beams*
Source: *Ashok B. Lall Architects*

Scan for More Information

Bubble Deck Slab

In this method of slab construction, recycled plastic balls are laid over and tied to the reinforcement network and then the concrete is poured. The balls replace the concrete which was not supposed to take structural loads. This considerably reduces the weight of the slab which results in a considerable decrease in the requirement of steel in the structure.

Scan for More Information

***Figure 130**: Construction of a bubble deck*
***Source:** Butterflies Resilience Centre, Ashok B Lall*

AAC Waffle Slab

AAC blocks, also referred to as Autoclaved Aerated concrete blocks are a type of precast building material that's lightweight, durable, and energy-efficient.

AAC Waffle slabs are a type of precast concrete composite floor slab that can be used for roofs and floors. In this, AAC blocks are placed at intervals on the flat formwork. Reinforcement steel is placed making rib beams. Light reinforcement is placed over the blocks, tying onto the rib beams. Concrete is cast on top. The AAC blocks reduce the thermal conductivity of the slab.

Scan for More Information

***Figure 131:** Inverted T-beams Bubble deck roof after cement is poured*
***Source:** Adobe Stock Image*

Precast- Ferrocement Channel Roof

Ferrocement is a type of reinforced concrete that's made by applying a thin layer of concrete over a mesh of steel, expanded metal, or woven metal. The concrete absorbs compression, while the steel absorbs tensile and shear stresses.

Figure 132.1

Figure 132.2
Figure 132: *Construction of a ferrocement roof channel*
Source: *Auroville Earth Institute*

The roof is done with U-shaped ferrocement channels which are then covered with other ferrocement panels, so as to create a hollow cavity which is ventilated at both ends. The air cavity provides insulation in the roof and the precast members speed up the construction process.

The following structural system only offers a reduction in the requirement of reinforcement steel and concrete. It does not play any insulating role in the building envelope.

Confined Masonry

In this method of masonry, the load bearing walls are erected first and then the columns are erected. This eliminates the need to provide shuttering on two sides of the column. The wall acts as the formwork.

Since the walls are load-bearing, the column sizes ar small, equal to the width of the wall. This masonry considerably reduces the requirement of concrete and steel in construction.

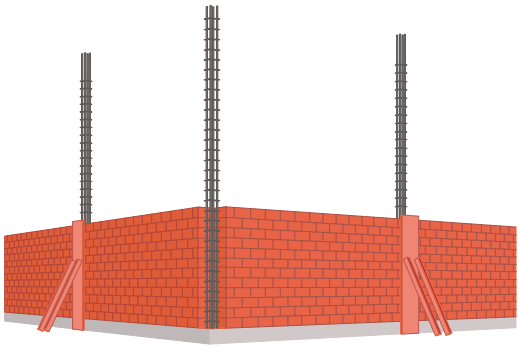


Figure 133: *Confined Masonry Construction*
Source: *Ashok B. Lall Architects*

Scan for More Information

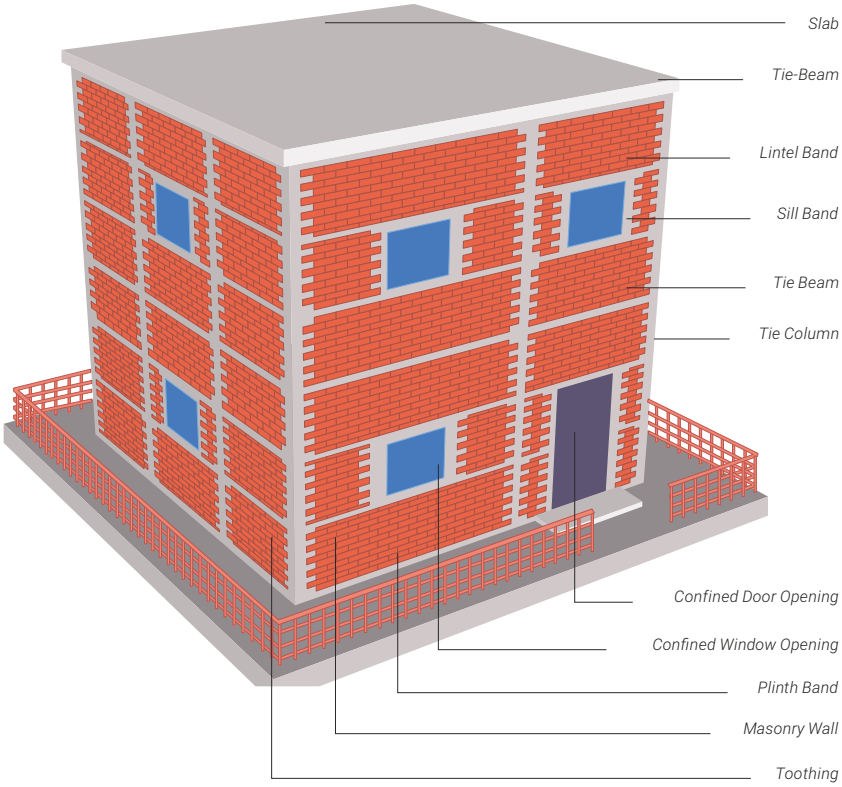
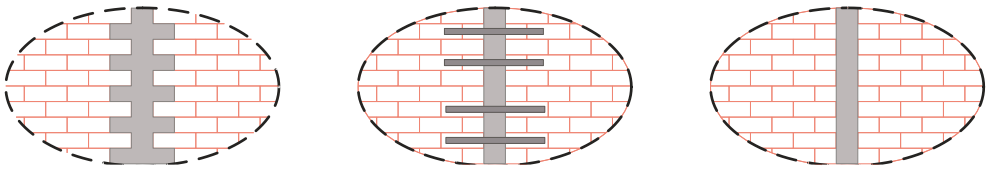


Figure 134: *Design of Confined Masonry Structures*
Source: *Ashok B. Lall Architects*

Wall-to-Tie-Column Interfaces:



Toothted Connection

Dowel Connection

No Connection

SPECIAL MENTION!

Rohtak Dome

In areas around UP and Haryana, there are some specially skilled masons who can build flat domes for your home. Because of their flat nature, it is easy to build above them. They do not use any shuttering and eliminate the use of reinforcements unlike conventional RCC slabs.

Figure 135.1

Figure 135.2

Figure 135: *Rohtak Dome*
Source: *https://rohtakdome.com*

Roofing

We usually observe that the top floor of a building gets very uncomfortably hot. In warm climates, the roof of a building is the most susceptible to heat gain because it is constantly exposed to the sun.

Therefore to maintain optimum indoor temperatures inside your home, it is crucial to protect your roof from heat gain.

Providing a light structure (for example, metal frame and polycarbonae sheets) on the terrace stops most of the sun's heat radiations from falling on the building roof. This protects the top floor from getting heated up. The shed also makes the shaded terrace space more usable for the residents. In cases where an additional floor is constructed in later years of a building, the light structure can easily be dismantled and re-installed on the raised terrace.

Other methods to make the roof 'cool' are as follows-

- **Use a light-coloured roof finish such as china mosaic, or limewash, or a heat reflective paint so as to reflect the sun's rays**
- **Use an insulating material such as extruded polystyrene under the roofing finish so as to reduce the conduction of heat through the roof**
- **Build the roof structure with something heavy such as RCC so as to delay and to reduce the effect of the afternoon sun**

Following are some roof constructions that incorporate all the above suggestions.

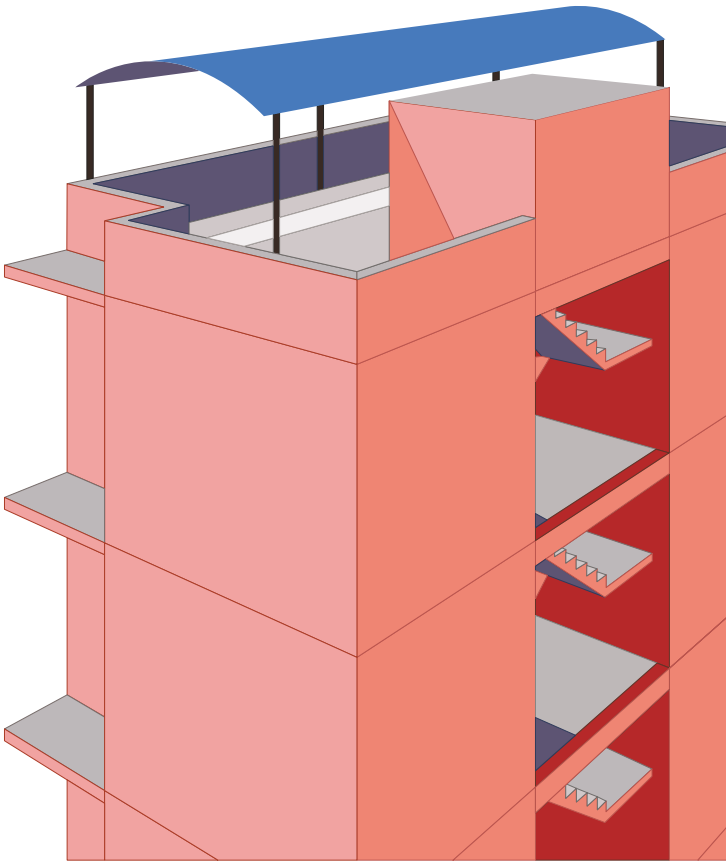


Figure 136: *The temporary shed*
Source: *Ashok B. Lall Architects*

Terracing with 50mm Thick Poly-Urethane Foam Insulation

U-VALUE refers to the rate of heat transfer through matter. Lower U-values of the external envelope are desirable for keeping the home thermally comfortable.

FINISHING LIGHT COLOR TILE

CONCRETE LAID TO SLOPE (MINIMUM 50MM)

Then, to achieve slope in the terracing, we lay concrete (min.50mm) over the insulation. This conrete layer is then further finished with a china mosaic/ light color tile finish. The joints between these tiles act as a breathable network, which help in evaporation of absorbed moisture.

50 THICK PUF

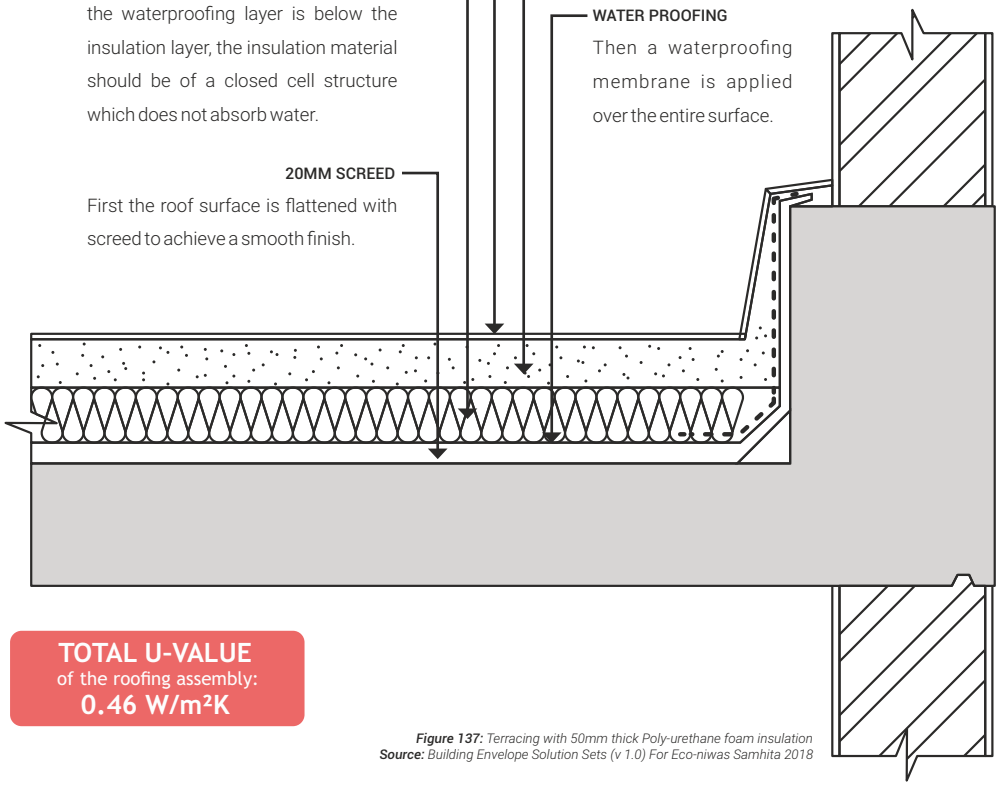
Next, a 50mm thick PUF insulation is put on the waterproofing layer. There should be no gap at the joints between adjacent PUF boards to ensure continuity of the insulation layer. Since, the waterproofing layer is below the insulation layer, the insulation material should be of a closed cell structure which does not absorb water.

WATER PROOFING

Then a waterproofing membrane is applied over the entire surface.

20MM SCREED

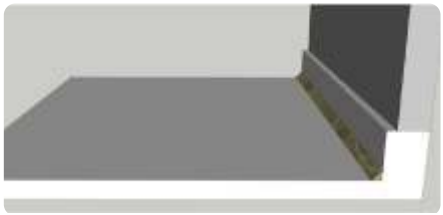
First the roof surface is flattened with screed to achieve a smooth finish.



TOTAL U-VALUE
of the roofing assembly:
0.46 W/m²K

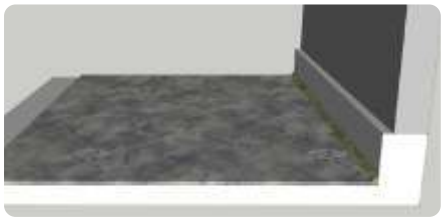
Figure 137: *Terracing with 50mm thick Poly-urethane foam insulation*
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

Construction



STEP 1

Triangular wedge to enable turning of waterproofing layer.

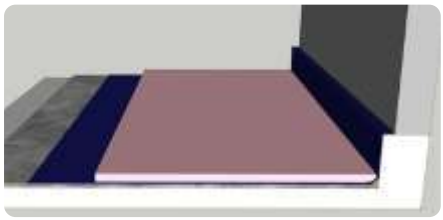


STEP 2

20mm Thick, screed to level the top of terrace slab.

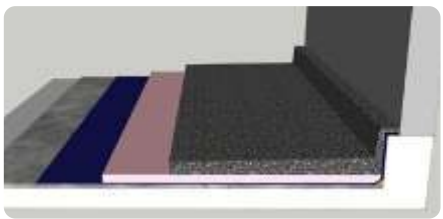
STEP 3

Waterproofing layer to turn and fold over the upturn/ terrace parapet base.



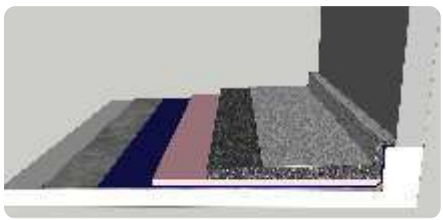
STEP 4

50thick PUF insulation boards placed over the waterproofing layer.



STEP 5

Concrete laid over insulation to achieve desired slope in terracing.



STEP 6

The finishing material is preferably light color tile to reflect solar radiation.

Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

SPECIAL MENTION!

Ricron Panels

Ricron Panels, a Gujarat based company has developed an alternative to the conventional corrugated metal sheets.

Corrugated Eco-Roof Sheets are made from plastic and aluminium composite which gives them withstanding properties against weather, yet it stays light weight and cost-effective. As these housing roofing sheets are made from plastic and aluminium waste, they are eco-friendly.

They are termite proof, rust proof, waterproof, light weight, cost effective, fire resistant and decay free.

For more information, visit:
https://www.ricron.com/application/residential-roofing

Figure 138: *Metal Sheets*
Source: *www.ricron.com*

Terracing with 100mm Thick Foam Concrete Insulation

CONCRETE LAID TO SLOPE (MINIMUM 50MM)

Then, to achieve slope in the terracing, we lay concrete (min.50mm) over the insulation. This conrete layer is then further finished with a china mosaic/ light color tile finish. The joints between these tiles act as a breathable network, which help in evaporation of absorbed moisture

FINISHING LIGHT COLOR TILE

100 THICK FOAM CONCRETE

Next, 100mm thick foam concrete insulation is put on the waterproofing layer.

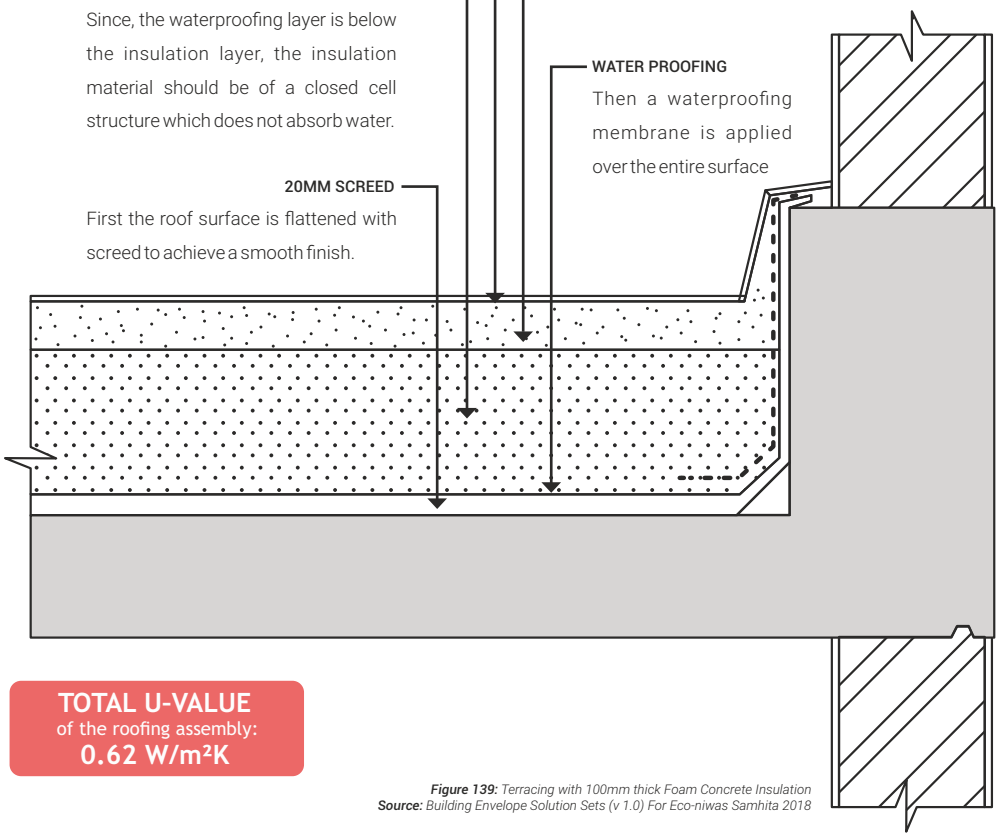
Since, the waterproofing layer is below the insulation layer, the insulation material should be of a closed cell structure which does not absorb water.

20MM SCREED

First the roof surface is flattened with screed to achieve a smooth finish.

WATER PROOFING

Then a waterproofing membrane is applied over the entire surface



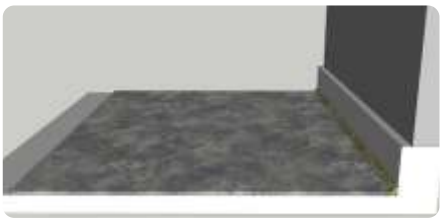
TOTAL U-VALUE
of the roofing assembly:
0.62 W/m²K

Figure 139: *Terracing with 100mm thick Foam Concrete Insulation*
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

Construction

STEP 1

Triangular wedge to enable turning of waterproofing layer.

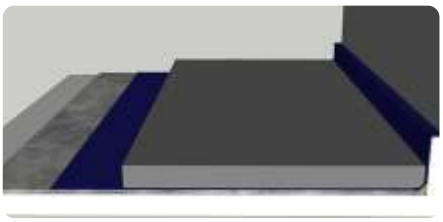


STEP 2

20mm Thick, screed to level the top of terrace slab.

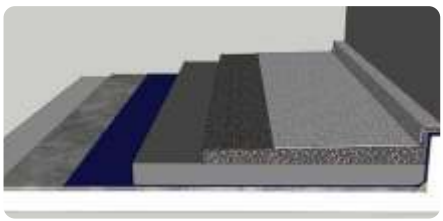
STEP 3

Triangular wedge to enable turning of waterproofing layer.



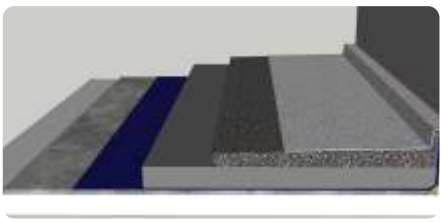
STEP 4

100 mm thick foam concrete insulation boards placed over the waterproofing layer.



STEP 5

Concrete laid over insulation to achieve desired slope in terracing.



STEP 6

The finishing material is preferably light color tile to reflect solar radiation.

Source: *Building Envelope Solution Sets (v 1.0)*
For Eco-niwas Samhita 2018

Walling

The conventionally used fired red clay brick is made from top-soil (which is important for agriculture) and has very high embodied energy.*

Therefore, it is essential to choose alternative walling materials.

KEY CONCEPTS

1. U-Value refers to the rate of heat transfer through matter. Lower U-values of the external envelope are desirable for keeping the home thermally comfortable.
2. *Embodied energy is the total energy spent in the processing and production of a material.
3. **Low operational energy = Lesser cooling requirements in your home

Figure 140: *Plaster on the red clay brick*
Source: *Adobe Stock Images*

*There are several options widely available in the market today that not only have low embodied energy, but also have better thermal properties. Good thermal properties in external walling materials lead to low operational energy** and costs for the building.*

Load Bearing

For buildings of upto Ground + 3 floors, constructing a load-bearing structure is a good option, both economically and environmentally. This is because it reduces the amount of RCC work in its construction.

Figure 141: *Bricks made entirely from construction waste*
Source: *Adobe Stock Image*

Construction and Demolition Waste Block

These blocks are made using the waste that is produced by the construction industry.

The production of these blocks does not require high temperature firing and also solves the problem of disposal of construction waste.

Size available: 230mm x 115mm x 75mm (can be customized)
U-Value of a 230mm thick wall: 3 W/m^2K (which is comparable to that of red bricks)
The operational energy of the building does not get much reduced since the insulating properties of these blocks are not really better than the conventional red bricks.
The embodied energy of a C&D Waste Block is 35-40% less than that of a conventional red brick.
Climate zone: Suitable for Hot & Dry and Composite Climates.
Limitations: These blocks are heavier than the usual red bricks.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Fly-Ash Bricks

Fly ash bricks are manufactured using fly-ash, lime and gypsum. Fly-ash is an industrial waste produced by thermal power plants.

Size available: 230mm x 115mm x 75mm
U-Value of a 230mm thick wall: 3.7 W/m^{2}K (which is comparable to that of red bricks)
The operational energy of the building does not get much reduced since the insulating properties of these blocks are not really better than the conventional red bricks.
The embodied energy of a Fly-ash brick is 50-55% less than that of a conventional red brick.
Climate zone: Suitable for all Climates.
Limitations: Its manufacturing is economical only in areas near thermal power plants.

Figure 142: *Fly-ash Brick Stack*
Source: *Adobe Stock Image*

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Slag Cement Block

A variation to the Fly-ash brick is the Slag- Cement block. This block is manufactured using another industrial waste, that is, **Slag**.

Slag is the waste product of metal industries. It is mixed with appropriate proportions of cement to attain strength.

Slag-cement blocks are also available in Hollowcore modules, which give better insulative properties and reduce the weight of construction.

Figure 143: *Slag cement block*
Source: *Adobe Stock Image*

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Compressed Stabilized Earth Blocks (CSEB)

CSEB is produced by compressing together a mixture of soil, sand, a stabilizer (cement/ lime/ other ad mixtures) and water.

The blocks produced using a press machine, are sun-dried as opposed to the conventional red bricks which are fired in a kiln.

Size available: 230mm x 115mm x 75mm (can be customized)
U-Value of a 230mm thick wall: 3.7 W/m^2K (which is comparable to that of red bricks)
The operational energy of the building does not get much reduced since the insulating properties of these blocks are not really better than the conventional red bricks.
The embodied energy of a CSE Block is 65-75% less than that of a conventional red brick.
CO2 emissions are minimal in the production process.
Another important aspect of **CSEB is its disposability**. Since the raw materials are natural, with only meager amounts of admixtures, they do not contribute much to Construction and Demolition waste at the end of their life cycle.
Climate zone: Suitable for all Climates.
Limitations: The composition of the soil which is naturally occuring at any location varies a lot. Experience is needed to figure out the right proportions of the sandy soil, clayey soil, stabilizers and water.

Figure 144: *Wall constructed with CSEB Blocks*
Source: *Adobe Stock Image*

Ideally, the soil used is sub-soil which is dug out from the site itself. Alternatively, ready-made blocks are also available with local vendors. Use of sub-soil prevents the topsoil, which is essential for agriculture, from getting depleted for making burnt red bricks.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

NOTE FOR BUILDERS AND CONTRACTORS

If CSEB is to be used for a load bearing structure, the block's compressive strength should be checked to be at least 8MPa.

Reinforced Hollow Interlocking CSEB

A variation to the regular CSEB, the Hollow Interlocking CSEB does not use mortar between two layers of masonry. Slurry is only poured through the holes. Reinforcements easily pass through these holes at structurally designated locations, resulting in a kind of confined masonry.

Figure 145: *Earth Blocks*
Source: *Earth Blocks India*

Size available:
300mm x 150mm x 90mm

U-Value
of a 300mm thick wall: 2.8 W/m^{2}K
(which is better than that of red bricks)

The operational energy
of the building gets slightly reduced because the block dimensions lead to a thicker external wall.

The embodied energy
of a CSE Block is 60-70% less than that of a conventional red brick.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Reinforced Hollow Concrete Blocks

Hollow concrete blocks can be reinforced with rebars at structurally designated locations to build high strength load bearing walls. The hollow cores which are not reinforced, act as air pockets in the wall, thus providing it an insulative property.

The blocks are lightweight and consume lesser raw materials as opposed to solid concrete blocks.

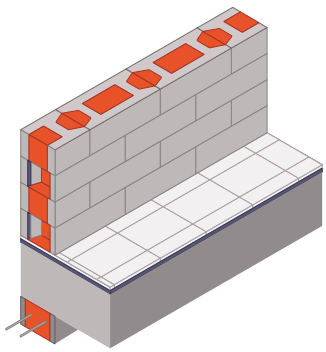


Figure 146: *Cross Section Image of reinforced hollow concrete blocks*
Source: *Ashok B. Lall Architects*

Size available:
Various modular sizes are available in the market.

U-Value
of a 200mm thick wall: 2.5 W/m^{2}K
(which is better than that of red bricks)

The operational energy
of the building gets slightly reduced because of better insulating properties of the blocks.

The embodied energy
of a Hollow Concrete Block is 60-70% less than that of a conventional red brick.

Climate zone:
Suitable for all Climates.

Limitations:
When mortar is filled between two courses of the masonry, the vertical hollow cores are difficult to avoid, and thus end up getting filled with mortar to some extent.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Reinforced Hollow Fired Clay Blocks

Hollow clay blocks can be reinforced with rebars at structurally designated locations to build high strength load bearing walls. The hollow cores which are not reinforced, act as air pockets in the wall, thus providing it an insulative property.

The blocks are lightweight and consume lesser raw materials as opposed to solid clay bricks.

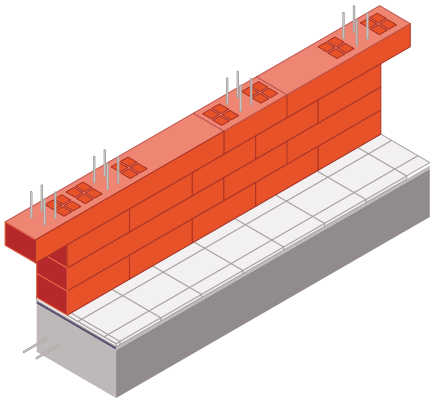


Figure 147: *Cross section image of reinforced hollow fired clay blocks*
Source: *Ashok B. Lall Architects*

Size available:
300mm x 150mm x 75mm

U-Value
of a 150mm thick wall: 1.3 W/m^{2}K
(which is better than that of red bricks)

The operational energy
of the building gets reduced because of better insulating properties of the blocks.

The embodied energy
of a Hollow Clay Block is 50% less than that of a conventional red brick.

Climate zone:
Suitable for all Climates.

Limitations:
When mortar is filled between two courses of the masonry, the vertical hollow cores are difficult to avoid, and thus end up getting filled with mortar to some extent.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

SPECIAL MENTION!

Agrocrete

GreenJams, an Indian company based in Andhra Pradesh and Meerut has developed a special brick called Agrocrete. It consists of discarded plant matter that would otherwise be burnt. Using a unique binding material, these blocks gain strength that is equivalent to concrete blocks.

Figure 148: *Agrocrete*

Non-Load Bearing

For buildings with more than 4 storeys, a framed structure has to be built. In this case, choosing lightweight walling materials would lead to a reduction in the RCC requirements.

Autoclaved Aerated Concrete

Autoclaved aerated concrete (AAC) block is a lightweight and highly insulating block.

For carrying out masonry work, a non-shrink grout should be added to the mortar. This should be used between the blocks as well as at all junctions of mortar and RCC work.

The internal and external surfaces of an AAC wall should be provided with a GI chicken wire-mesh over entire AAC block masonry including overlap at concrete-masonry junctions. This would help in avoiding shrinkage cracks in the future.

Figure 149: *Wall construction with Autoclaved Aerated Concrete*
Source: *Adobe Stock Image*

Size available: Various modular sizes are available
U-Value of a 200mm thick wall: 0.77 W/m^2K (which is a lot better than that of red bricks)
The operational energy of the building gets considerably reduced because of high insulative properties of the blocks.
The embodied energy of an AAC Block is 45-50% less than that of a conventional red brick.
Climate zone: Suitable for all Climates.
Limitations: Caution has to be taken against moisture ingress and cracks developed during transportation, storage and application. Size available: Various modular sizes are available.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Hollow Clay Blocks with Horizontal Perforations

These blocks have horizontal cavities that improve the thermal performance of the wall. These blocks are used for external walls and are joined with a dryfix adhesive or cement mortar between the blocks.

Since the blocks are industrially produced, they have clean finishing and can also be used for exposed masonry, thus eliminating the use of plaster and paints.

Figure 150: *Stack of Hollow Clay Blocks with Horizontal Perforation*
Source: *Adobe Stock Image*

Size available:
400mm x 200mm x 150mm &
400mm x 200mm x 200mm

U-Value
of a 200mm thick wall: 1.0 W/m^{2}K
(which is a lot better than that of red bricks)

The operational energy
of the building gets considerably reduced because of high insulative properties of the blocks.

The embodied energy
of a Hollow Clay Block is 45-50% less than that of a conventional red brick.

Climate zone:
Suitable for all Climates.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Walling Assemblies

Out of all the walling materials listed above, AAC Blocks are the most widespread and popularly used. Other options are not readily available in all parts of the country. In such situations, home-owners and builders end up using the conventional red bricks for their homes.

For such cases, there is a possibility of building the external walls in assemblies that considerably improve the thermal performance of the building interiors.

Though the embodied energy of such walling assemblies are not lesser than that of the conventional way of building, they reduce the operational energy of the building by huge amounts.

Disclaimer!

The wall assemblies recommended here are for external walls. These are the walls that are exposed to the outside air.

Walls that are shared with neighbouring buildings are not considered as external walls.

230mm Thick Brick Cavity Wall with Insulation

This wall assembly comprises a 115-mm outer wall and 75-mm inner wall with 40-mm-thick expanded polystyrene insulation in-between two brick layers, which are held together by wall ties. This system ensures a continuous 230-mm wall thickness as in traditional method and provides better insulation.

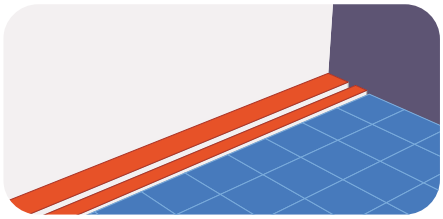
U-Value of a 230mm thick wall: 0.62 W/m2K

Climate Zone: Suitable for all Climates

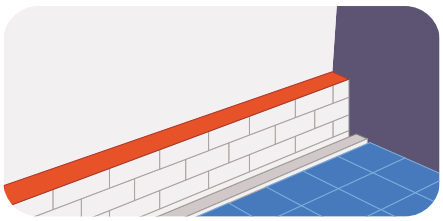
RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

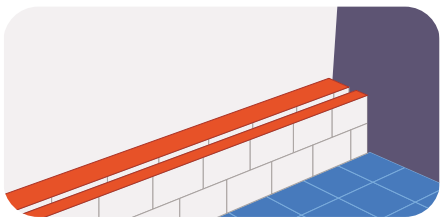
Construction Steps



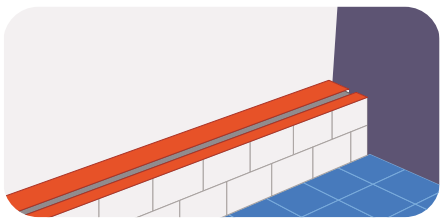
STEP 1
Laying Leveling course (about 40mm) to begin brickwork from a flat surface.



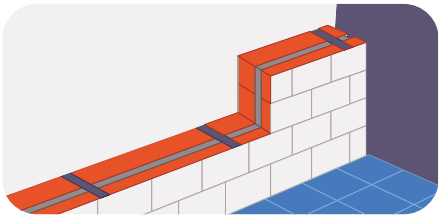
STEP 2
Start with layering 3 courses of exterior 115 thick wall



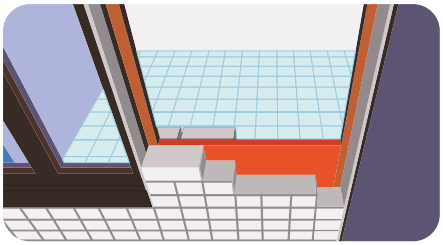
STEP 3
Leave a gap of 40mm & lay two courses of 75 thick wall such that the top level matches for both courses



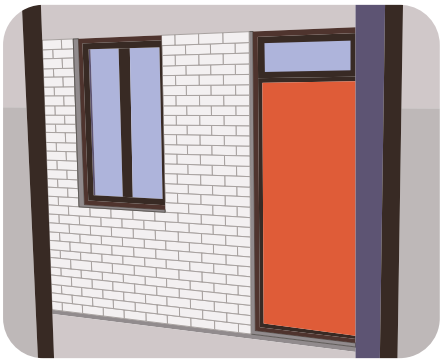
STEP 4
Insert 40mm thick insulation inside the cavity



STEP 5
Place wall ties at every 600mm and repeat the next set.



STEP 6
To avoid thermal bridgingthe cavity between the inside and outside walls should be be enclosed with a wooden peice at the masonary opening for a door or window as shown in the image above.



Outside Elevation

Source: *ABuilding Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

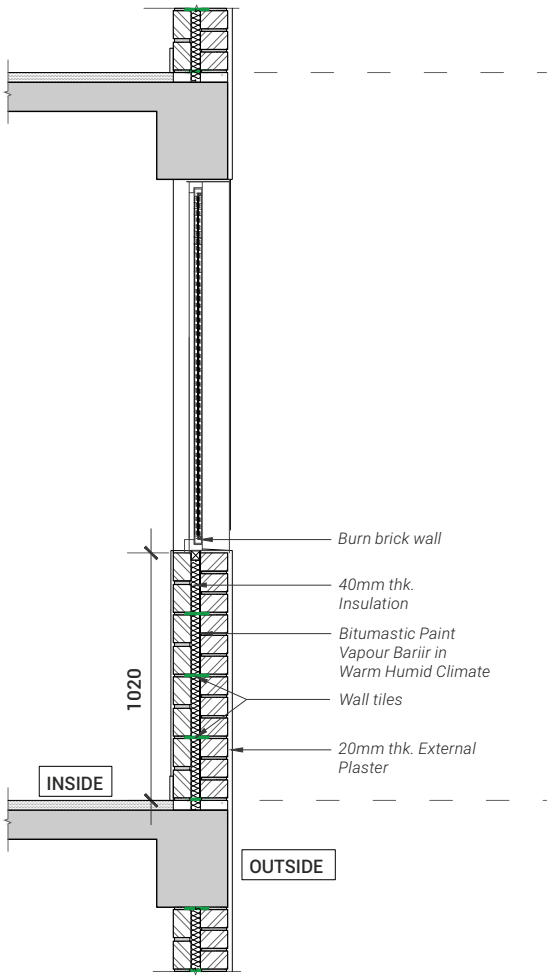


Figure 151: *Wall Section of 230mm thick Brick Cavity*

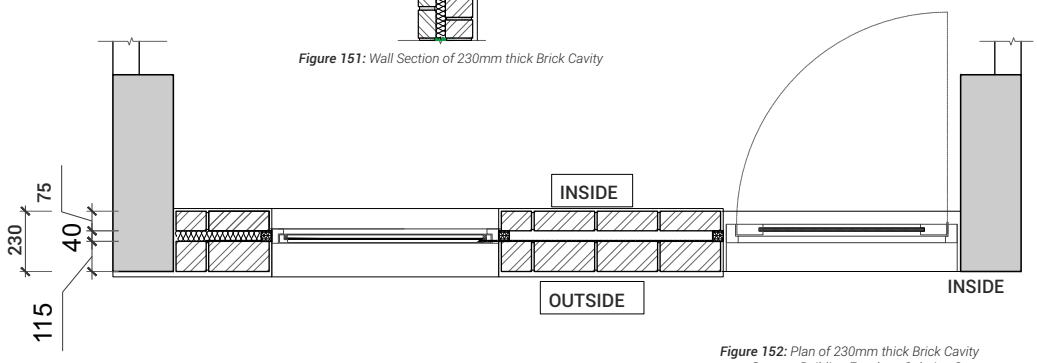


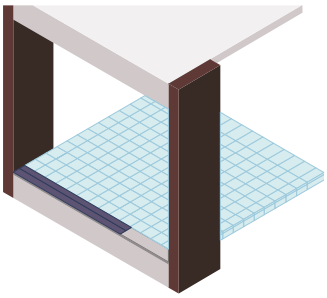
Figure 152: *Plan of 230mm thick Brick Cavity*
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

115mm Thick Brick Wall + 100mm Thick AAC Block wall

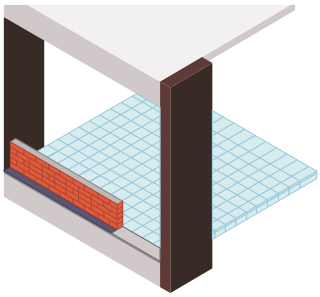
This wall assembly comprises a 100-mm-thick AAC blockwork outer wall and 115-mm-thick inner brick wall. The outer face of the inner wall should be painted with a bitumastic paint layer to act as a vapour barrier in warm-humid climates. The total wall assembly will be 230-mm thick.

U-Value of a 230mm thick wall: 1.1 W/m2K

Climate zone: Suitable for all Climates.

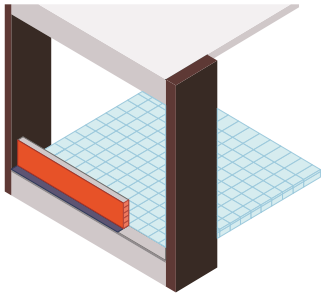


STEP 1
Laying Leveling course (about 40mm) to begin brickwork from a flat surface.

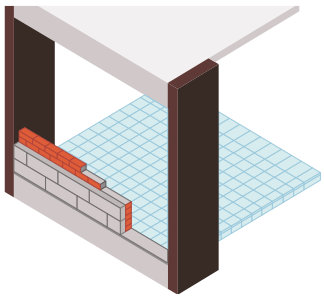


STEP 2
Raise the interior 115mm think brickwall.

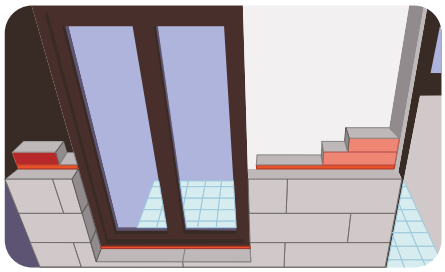
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*



STEP 3
Apply cemetatious vapour barrier in warm-humid climate.



STEP 4
Raise the exterior 100mm thick AAC blockwork after leaving a 15mm gap.



STEP 5
The bitumastic paint here also acta as an adhersive that bonds the outer AAC wall to the inner wall.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

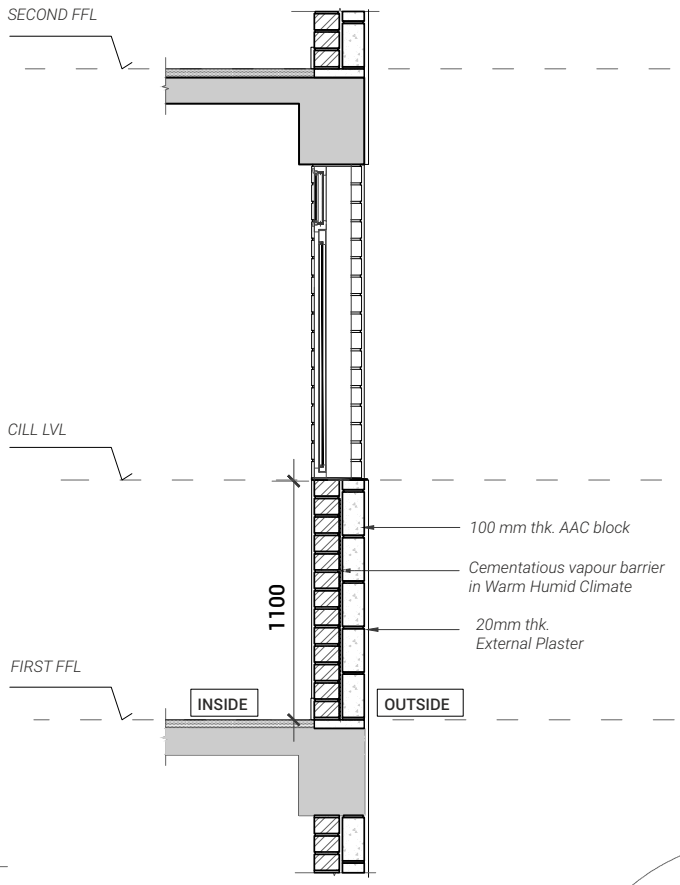


Figure 153: *Wall Section of 115mm Thick Brick Wall*

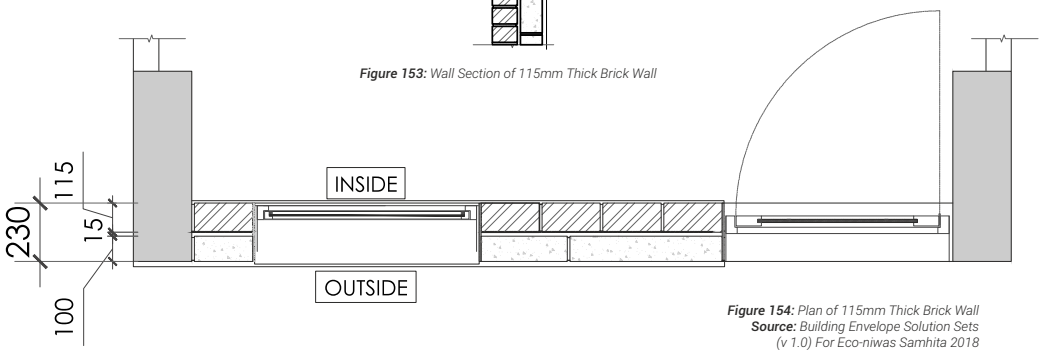


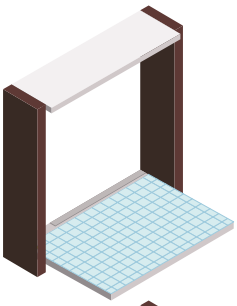
Figure 154: *Plan of 115mm Thick Brick Wall*
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

115mm Thick Brick Wall + Insulation on Interior Face

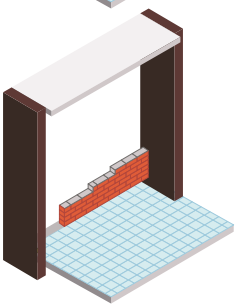
This wall assembly comprises a 115-mm outer brick wall with insulation on the inside. The insulation material of mineral wool may be fixed within a wooden/GI framework. Next, a gypsum plaster board is fixed onto this frame. The insulation material should cover the entire wall surface and must be tightly fitted within the framework, leaving no gaps. This is essential for the insulation to be effective. If a GI framework is used, then a nylon washer should be used to separate the framework from the wall. This avoids conduction from the wall to the GI framework.

U-Value of a 165mm thick wall: 0.57 W/m2K

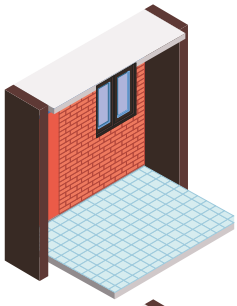
Climate zone: Suitable for all Climates.



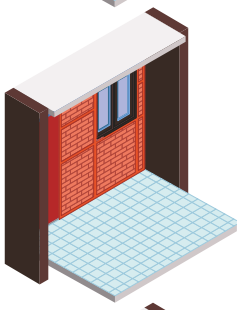
STEP 1
Laying Leveling course (about 40mm) to begin brickwork from a flat surface.



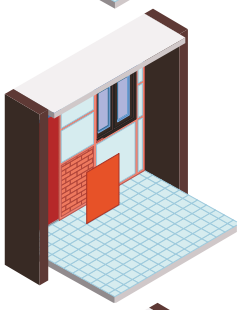
STEP 2
Start with laying the 115mm thick brick wall.



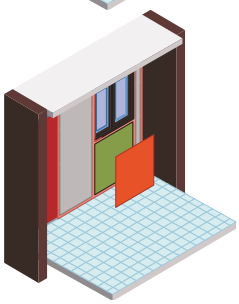
STEP 3
Complete the wall and install doors and windows.



STEP 4
Fix a wooden frame work to the wall as shown in image to the left.



STEP 5
Put insulation within the wooden framework.



STEP 6
Fix gypsum board panel on the wooden frame to enclose the inlsulation.

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

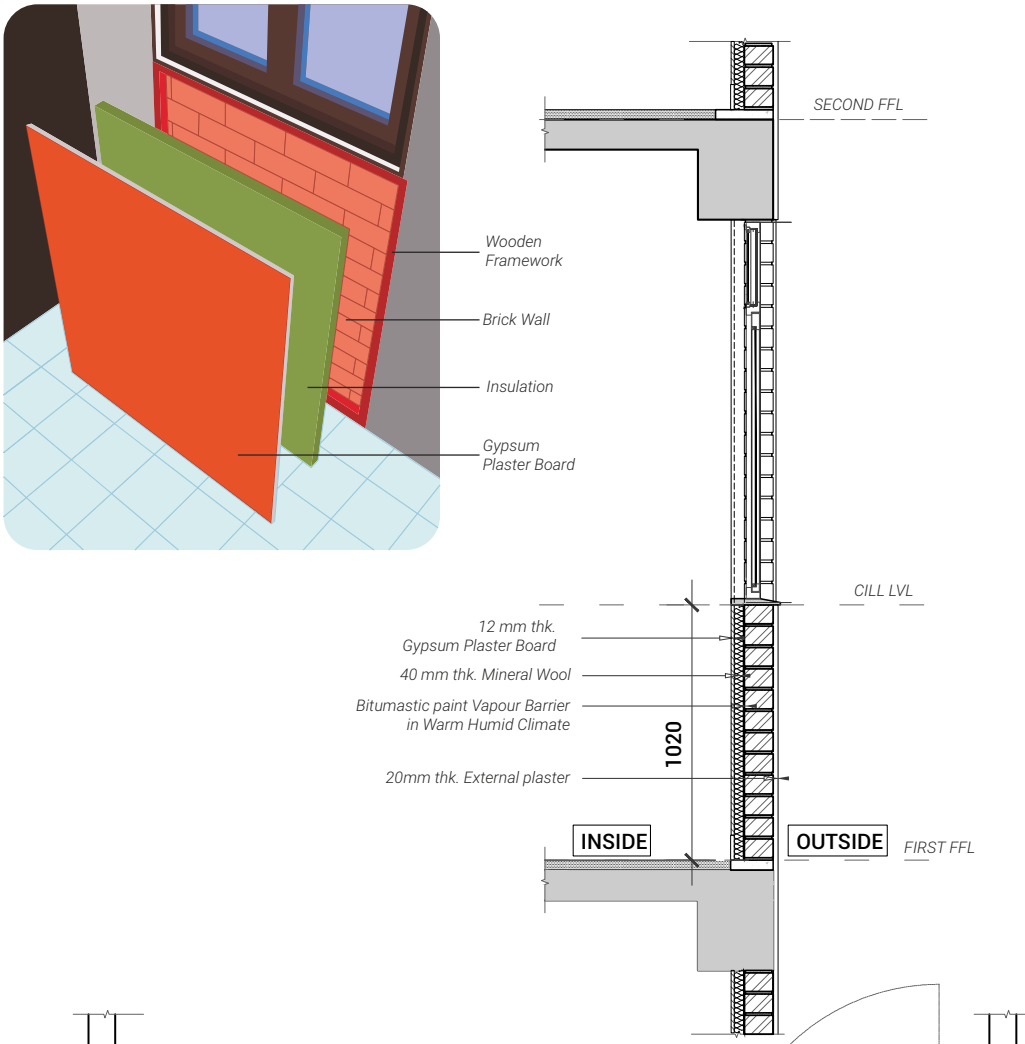


Figure 155: *Plan of 115mm Thick Brick Wall*

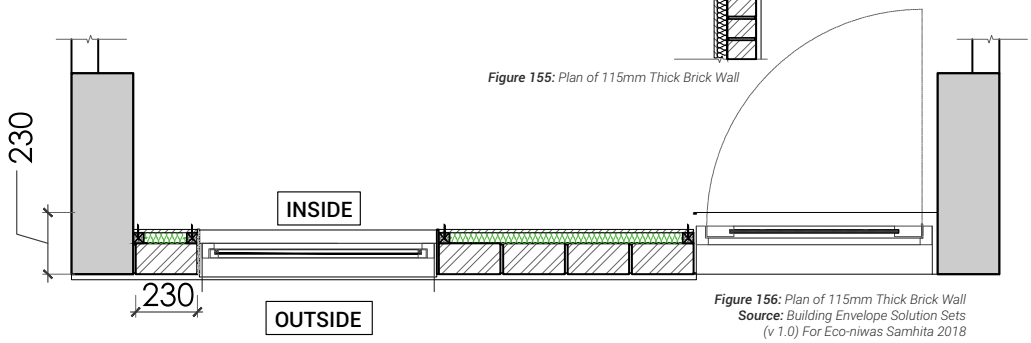


Figure 156: *Plan of 115mm Thick Brick Wall*
Source: *Building Envelope Solution Sets (v 1.0) For Eco-niwas Samhita 2018*

230mm Thick Rat-Trap bond Masonry- Fired Red Bricks

When only the conventional red bricks can be procured for constrcution, they can be used to build the walls in a Rat-trap Masonry. In this type of masonry, the bricks are laid in a vartical orientation to create air cavities while maintaining the wall thickness of 230mm. This system reduces the number of bricks that would have been used to build a conventional masonry wall. It also improves the thermal properties of the wall because of the trapped air cavities. Reinforcements are easy to place through the overlapping cavities at structurally designated locations. This leads to a confined masonry walling structure.

U-Value of a 230mm thick wall: 1.4 W/m2K

Climate Zone: Suitable for all Climates.

Limitation: The bricks laid across the width of the wall act as thermal bridges, reducing the wall's insulating potential.

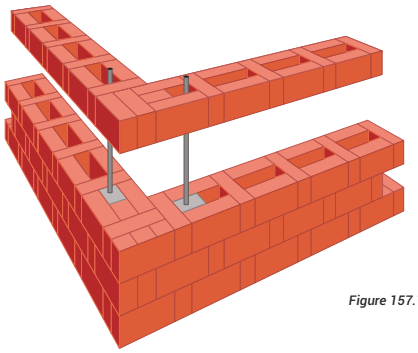


Figure 157.1

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

230mm Thick Rat-Trap Bond Masonry- Fired Red Bricks + AAC Blocks

As a variation to the Red brick Rat-trap bond masonry, if the transverse bricks that act as thermal bridges are replaced by AAC Blocks, it would considerably improve the insulating properties of the wall.

Limitations: The AAC Blocks have to be cut to get the 230mm length to span the wall thickness.

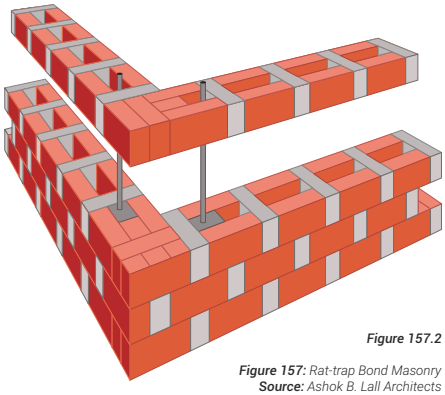


Figure 157.2

Figure 157: *Rat-trap Bond Masonry*
Source: *Ashok B. Lall Architects*

RECOMMENDATION SCORE FOR ECO-FRIENDLINESS

RECOMMENDATION SCORE FOR THERMAL COMFORT

Doors and Windows

Doors and windows are now fabricated in various materials. On one hand, there is Steel, Aluminium and UPVC. The manufacturing of these materials releases large amounts of of Co_2 and contribute to Global Warming.

On the other hand, there is Timber that has absorbed CO_2 during its life cycle. There are various certified forests and controlled sources of timber, that ensure sustainable forestry. It is a way of forest management that conserves its ecosystem.

Therefore, to construct a 'Green' Home, it is recommended to choose ethically sourced timber for your doors and windows. Check for certifications such as FSC, PEFC, PRAMAAN & SFI.

But be careful! Wood products must be seasoned, treated against termites and painted to be long- lasting.

- The first priority is to look for discarded ones and check whether they can be used for your home after putting in some work on them. This is called recycling of doors and windows. This process needs to be done at the early stages of construction to get the exact wall opening sizes that need to be provided

Figure 158.1

Figure 158.2
Figure 158: *Recycled Doors and Windows*
Source: *Ashok B. Lall Architects*

- Recycling of doors and windows may not completely fulfil the requirement of your home. For the remaining ones, for which new windows or doors have to be bought or fabricated, install Painted Timber doors and windows, using sustainably sourced timber

Figure 159: *Traditional Timber Door*
Source: *Adobe Stock Images*

- To make the windows air-tight, provide double-rebate overlap joints between frames and shutters

- If timber is not a suitable option, you can install 'recycled' steel or aluminium doors/ windows. These have a much lower embodied energy than their virgin metals

Figure 160: *Aluminium Door*
Source: *Indiamart*

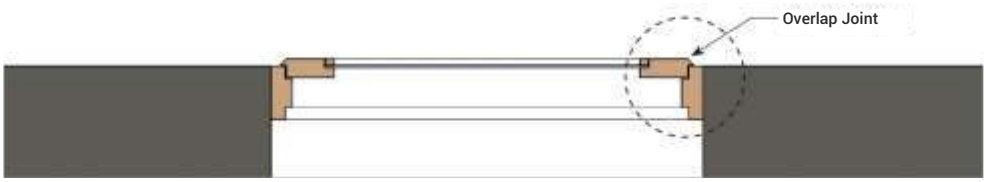


Figure 161: *Double rebate overlap joints between frames*
Source: *Ashok B. Lall Architects*

Figure 162: *Chaukhat with 4 Sided door frame*
Source: *Adobe Stock Images*

When a 4-sided door frame is used, there is no air gap, and hence no infiltration.

Figure 163: *Single Door with 3 sided door frame.*
Source: *Adobe Stock Images*

When a 3-sided door frame is used, there is an air gap between the door shutter and the floor, which allows infiltration.

- Use a true 'Chaukhat', which means a 4-sided door frame, for external doors. This prevents the unwanted movement of air between the inside and the outside, known as infiltration. It also keeps dust and insects from getting in

Figure 164.1

- When the weather outside is pleasant, you should be able to open the windows. To be able to do so, it is recommended to have 2 layers of shutters for all the external doors and windows. One layer of shutters is of course glass in case of windows and wood+glass in case of doors. The second layer is that of a mesh. This layer keeps the mosquitoes and any other insects out, while allowing natural ventilation

Figure 164.2
Figure 164: *Mesh for Doors and Windows*
Source: *Adobe Stock Image*

- For rooms where it is not feasible to provide a balcony because of space constraints, for example, when the rear setbacks are too narrow; install these door-height windows (with an incorporated railing) that double up as mini balconies. This can substantially improve ventilation. When the full height shutters are opened, a person can lean on the railings, somewhat giving the feeling of standing in a balcony

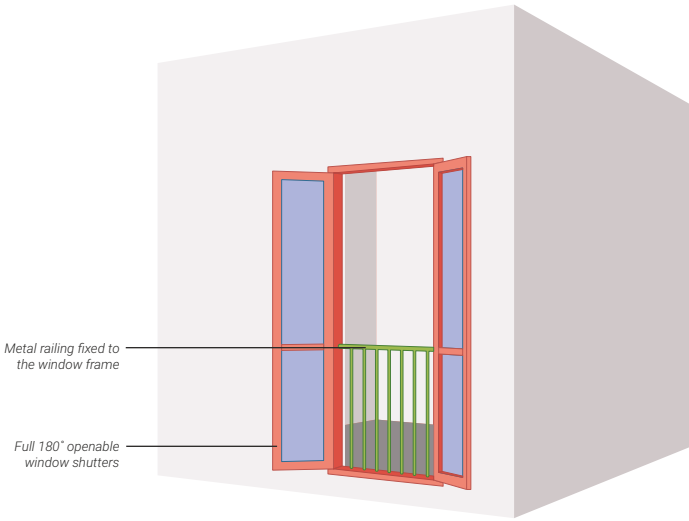


Figure 165: *Full height openable shutters with railings.*
Source: *Ashok B. Lall Architects*

Shading Devices

A shading device outside window openings is designed to cut-off solar radiation when it is undesirable.

Typically, external shading can be in the form of:

Overhang

This is the horizontal projection above window that shields it from direct solar radiation when the sun is at a high altitude, and also protects from rain.

Materials that can be used: cement board, fibre glass sheet, ferrocement, precast concrete panel, RCC and stone.

Side-fin

This shading element restricts direct solar radiation from the sides when the sun is at a lower altitude.

Materials that can be used: cement boards, perforated metal sheet, punched louvre GI panel, concrete/GRC jaali, WPC boards, bamboo, welded MS flats or a weather-resistant fabric.

Overhang and side-fins are generally fixed shading elements while the front screen is often movable.

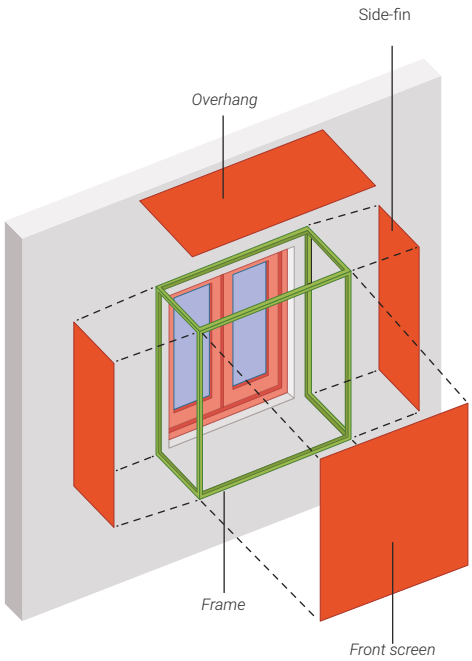


Figure 166: *Typical Shading Design Element*
Source: *Building Envelope solutions sets (V.10) for eco-niwas samhita 2018*

Front Screen

The front screen should be a movable/retractable system that allows some light even while shading. The screen can be drawn across the front of the window when the sun is directly facing the window.

Materials that can be used: Vertically suspended lightweight materials such as bamboo chiks, foldable fabrics (ferrari), cloth, and GRC panels

NOTE:
Curtains and blinds are not an effective system of shading. Since, these are installed indoors, the heat has already made its way to the building interior. To be effective, it is neccessary for a shading system to be installed outside the building.

Typical Shading Device Framework

If a projected frame of light metal section is fixed on the wall surrounding the window opening is provided (as shown in the wall section), it will help to attach the shading panels or screens conveniently. This frame would allow the user to easily install shading screens/chiks/ cloth, etc.

This typical box frame is made up of MS sections; other alternative options include aluminium, stainless steel, and GI.

The frame should be attached to the external wall with minimum surface area in contact with the wall. PVC sleeves can be used to separate the frame and wall and limit the conduction heat gains from the shading device to the envelope.

Figure 167: *Cement Board overhang with MS Frame*
Source: *Building Envelope solutions sets (V.10) for eco-niwas samhita 2018*

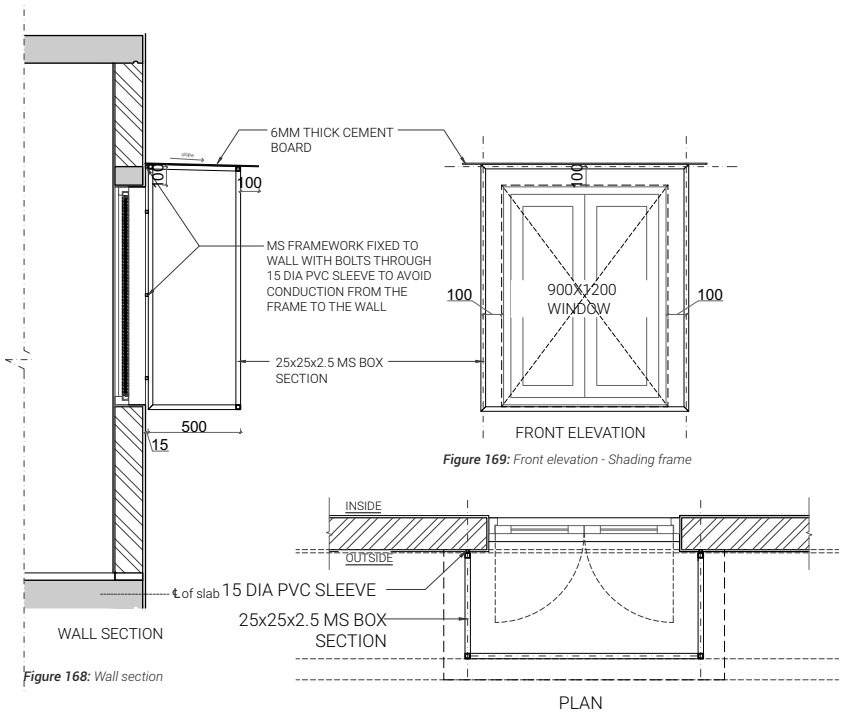


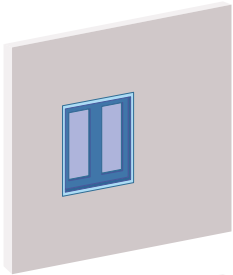
Figure 168: *Wall section*

Figure 169: *Front elevation - Shading frame*

Figure 170: *Plan*
Source: *Building Envelope solutions sets (V.10) for eco-niwas samhita 2018*

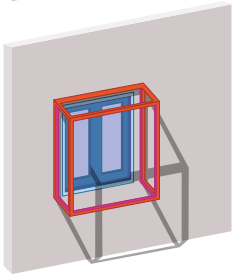
Construction Steps

This shading framework can easily adapt to various orientations



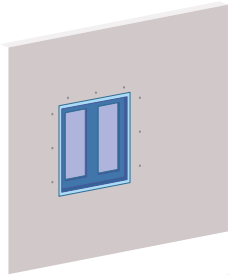
STEP 1

Taking the case of 900x1200mm standard window



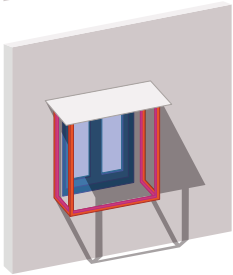
STEP 2

Drill holes, fit PVC sleeves that project out by about 15mm and align them in one plane.



STEP 3

Fix the MS box frame with bolts, each frame can come separately and be bolted.



STEP 4

Once the MS Frame is fixed properly, different shading devices can be installed over it.

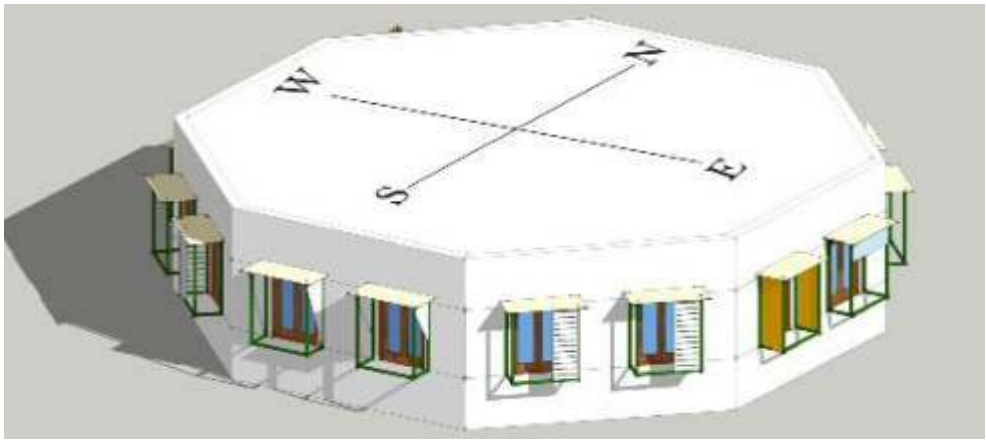


Figure 171: *Different forms of shading device element*
Source: *Building Envelope solutions sets (V.10) for eco-niwas samhita 2018*

Window Shading Device Components with Respect to Orientation

Northern Facade (Above Tropic of Cancer)

Overhang ✓	Side-fins	Front screen

The Northern facade in Northern India receives direct sunlight mainly during the early morning and late afternoons during summer. A 50cm to 60cm horizontal overhang protects windows from rain and provides shade from the high-altitude sun.

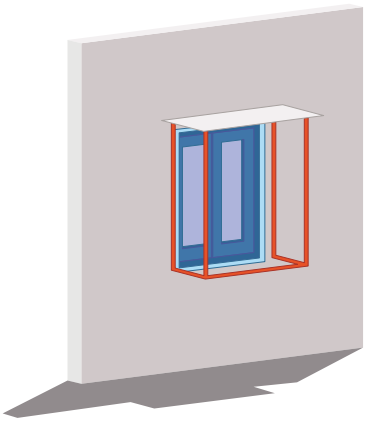


Figure 172.1

Northern Facade (Below Tropic of Cancer)

Overhang ✓	Side-fins ✓	Front screen

In Southern India, the Northern facade receives direct sunlight longer in the morning and evening than in the north. The sun's rays hit at a less oblique angle, so side fins on the east and west of the window are needed along with a horizontal overhang.

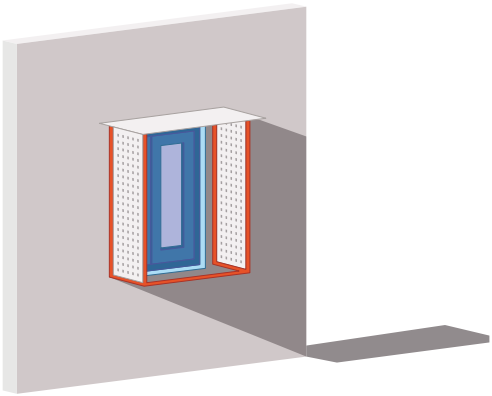


Figure 172.2

The Tropic of Cancer is an imaginary line around the Earth at 23.5° north of the Equator, marking the northernmost point where the Sun appears directly overhead.

North-Eastern/ North-Western Facade

Overhang ✓ | Side-fins ✓ | Front screen

The Northern facade in Southern latitudes of India, however, is exposed to direct solar radiation during the morning and evening hours for a much longer period of the year compared to the exposure in Northern latitudes. Also, the angle of incidence of the sun's rays on the façade is less oblique and more impactful. Hence, it is necessary to provide side fins on the East and Western sides of the window in addition to the horizontal overhand above the window.

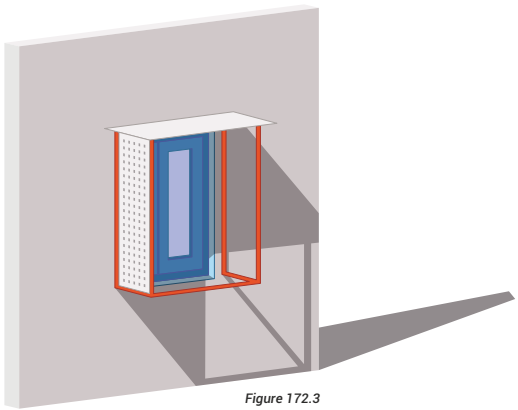


Figure 172.3

Eastern/ Western Facade

Overhang ✓ | Side-fins ✓ | Front screen ✓

The East and West facades receive strong direct sunlight all morning and afternoon, allowing deep penetration through the windows. They also receive oblique rays throughout the day, so shading is needed on all sides. A flexible front screen provides views and ventilation.

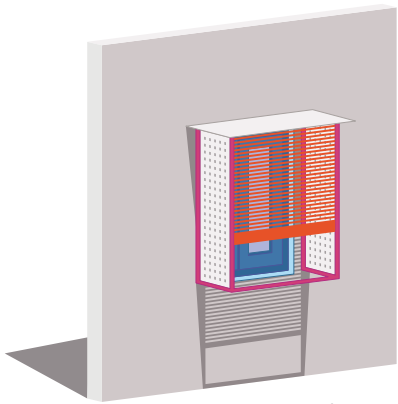


Figure 172.4

South-Eastern/ South-Western Facade

Overhang ✓ | Side-fins ✓ | Front screen ✓

The southeast and southwest facades receive solar radiation from both the lower altitude and overhead sun, necessitating shading on the sides and front. This can be achieved with fixed side fins and a movable front screen.

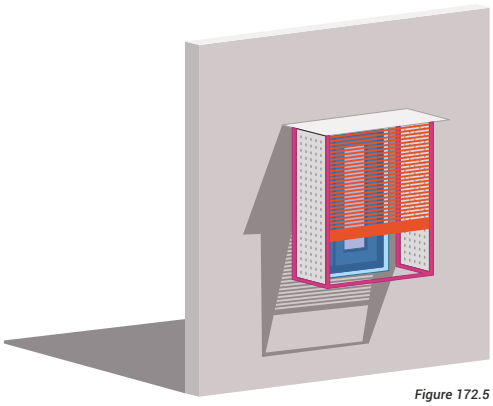


Figure 172.5

Southern Facade

Overhang	Side-fins	Front screen

Openings on the south facade receive less direct solar radiation due to the higher sun altitude, with overhangs playing a key role. Some sunlight enters from the east and west as the sun moves, so an overhang and fixed side fins are sufficient for shading

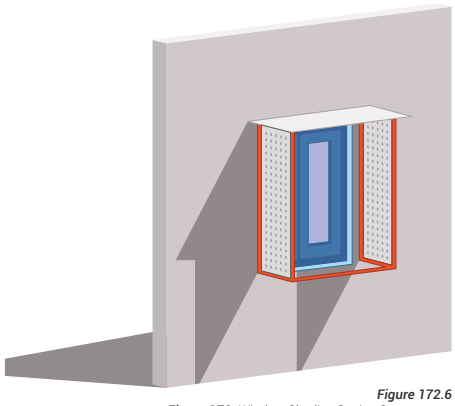


Figure 172.6
Figure 172: *Window Shading Device Components*
Source: *Ashok B. Lall Architects*

In case of balconies as well, the shading mechanism follows similar principles as in the case of windows.

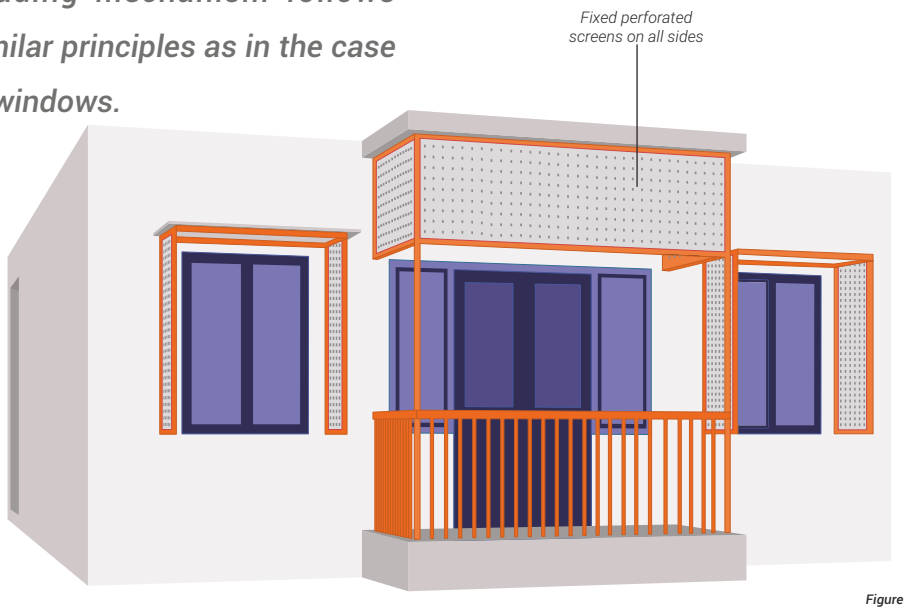


Figure 173.1

No matter what direction the balcony faces, it should have fixed perforated screens on all sides, starting at around 2100mm from finished floor level, upto the slab projection above.

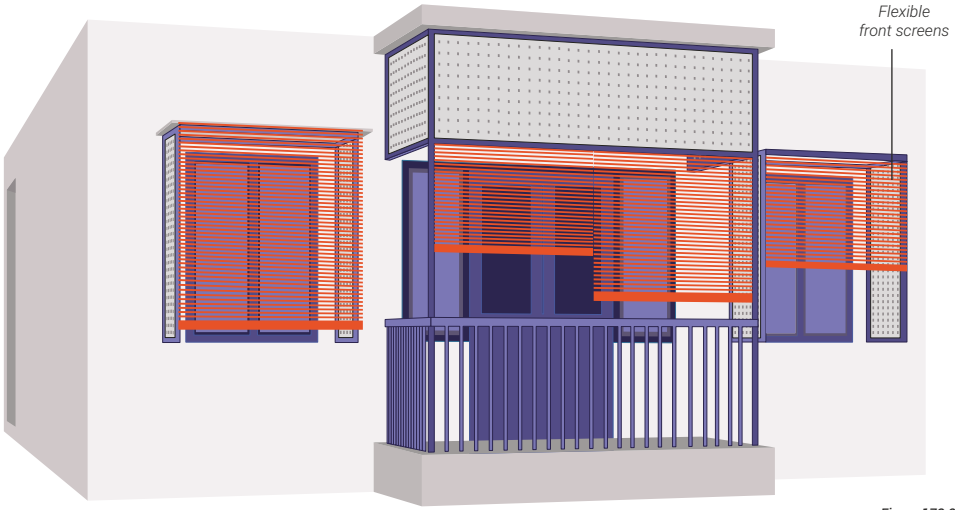


Figure 173.2

If the balcony faces east/west, add flexible front screens.

Figure 173.3
Figure 173: *Balcony Shading Device Components*
Source: *Ashok B. Lall Architects*

If there are no windows adjacent to a balcony on the facade, it is recommended to add side fins to the balcony shading framework. These side-fins also ensure security in case of houses where the balconies of different dwelling units are right adjacent to each other.

Quiz Time!

1. For Buildings up to how many floors is constructing a load-bearing structure considered a good option?

a Ground + 5
b Ground + 7
c Ground + 3
d Ground + 10

2. Which of the following is not an example of a shading device?

a Overhang
b Fins
c Front screen
d Column

3. Which of the following is an Eco Friendly for doors and windows?

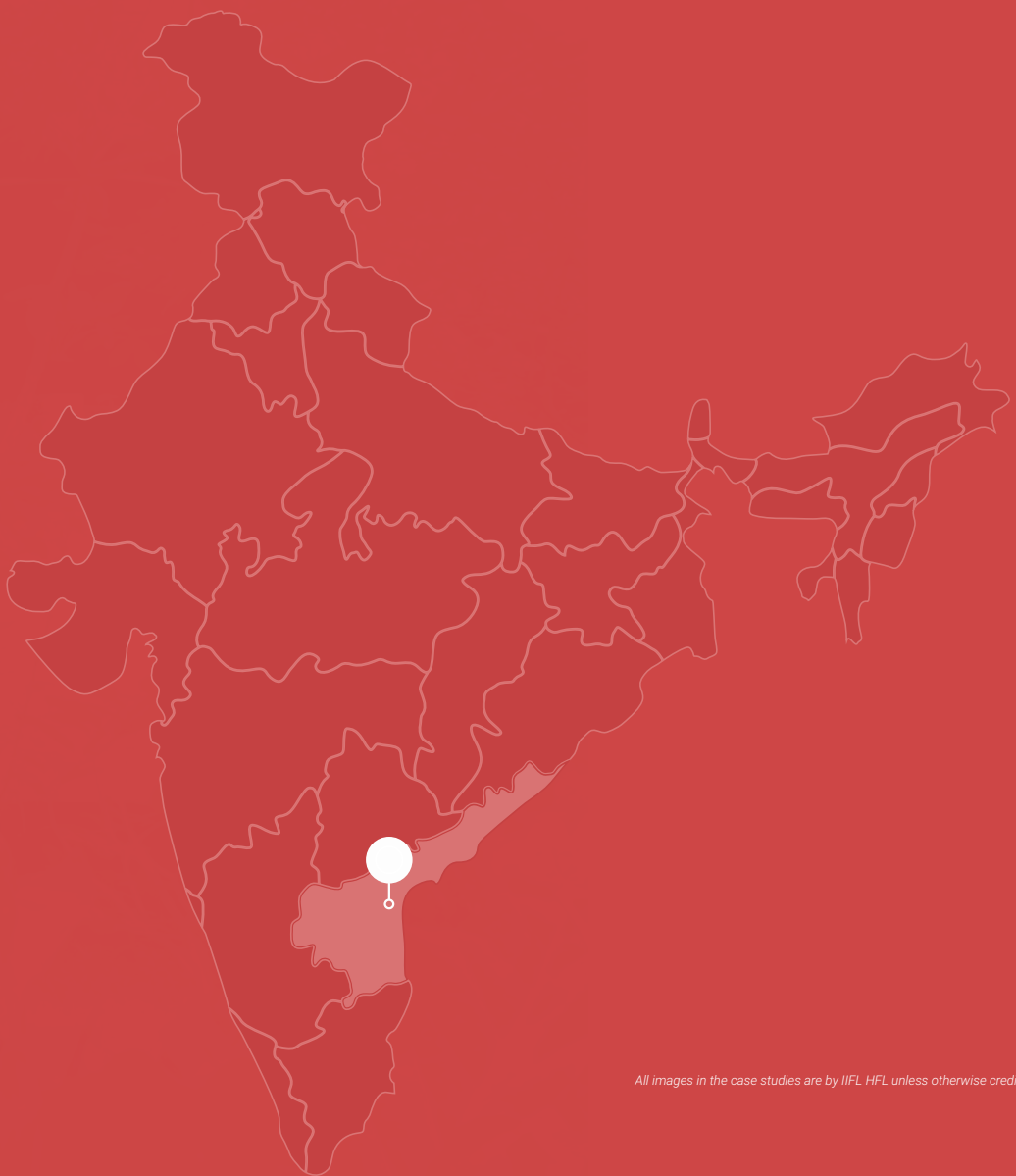
a Steel
b Timber
c Aluminum
d UPVC

GLOSSARY

Embodied Energy	The total energy consumed in the processing and production of building materials, including extraction, manufacturing, and transportation.
Operational Energy	Energy required for a building's operation during occupancy, including heating, cooling, lighting, and powering appliances.
AAC Blocks (Autoclaved Aerated Concrete Blocks)	Lightweight, durable precast building materials known for their energy efficiency and insulation properties.
Ferrocement	A reinforced concrete type made by applying a thin layer of concrete over a mesh of steel or other materials, enhancing strength and reducing weight.
Confined Masonry	A construction technique where load-bearing masonry walls are built first, and then reinforced concrete columns and beams are added around them to improve structural stability and earthquake resistance
U-value	A measure of heat transfer through building materials; lower U-values indicate better insulating properties.
Precast T Beam	A load-bearing structure with a T-shaped cross-section used in construction to support roofs and floors.
AAC Waffle Slab	A precast concrete composite or slab that incorporates AAC blocks to reduce thermal conductivity.
Rat Trap Bond	A masonry technique of wall construction that involves the use of bricks laid in a vertical position which creates cavity in the wall to enhance thermal performance and structural stability.
Reinforced Hollow Block	A type of block that incorporates reinforcement (steel bars & concrete) to improve structural integrity while maintaining lightweight properties.
CSEB (Compressed Stabilized Earth Blocks)	Building blocks made from compressed earth stabilized with cement or lime, offering sustainable construction options.
Insulation	A material or technique used in buildings to reduce heat transfer between the interior and exterior environments. It helps in maintaining indoor temperature, improving energy efficiency, and enhancing occupant comfort. Examples include polyurethane foam, AAC blocks, and cavity walls with insulation.

Facade	The exterior face of a building, often designed for aesthetic appeal and functional purposes like ventilation, shading, and thermal performance. Different orientations of facades (e.g., north, south, east, west) require specific design considerations to optimize natural lighting and energy efficiency

CASE STUDY
AUROVILLE



All images in the case studies are by IIFL HFL unless otherwise credited

VIKAS COMMUNITY – AUROVILLE EARTH INSTITUTE

Auroville

Figure 174: *CSEB Block in the Staircase Core*

Location

Sangamam and Vikas Community are located in the town of *Auroville, Tamil Nadu.*

Auroville is an experimental township located in Tamil Nadu adjacent to Pondicherry. The site in an area affected by environmental and social problems, including water scarcity, saline water intrusion, soil erosion and declining soil fertility, unemployment and inadequate housing, educational and medical facilities.

Figure 175: *Auroville, Tamil Nadu*

Building Orientation

- The building blocks in the Vikas Community are oriented in the North-South direction
- The apartments are arranged in a staggered layout to provide self-shading

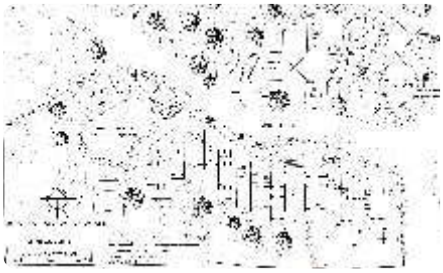


Figure 176: *Site Layout, Vikas Community*

Walling Material– CSEB Blocks

Vikas Community has used CSEB blocks for construction of walls. The earth dug out from excavation during the construction was used to manufacture these blocks. Depending on the workmanship and quality, CSE Blocks do not necessitate the use of plaster, especially for the interiors. It saves the material and cost that goes into plastering.

Figure 177: *CSEB Blocks as Walling Material*

When painted, the walls made with CSEB blocks look no different than a regular wall made out of clay bricks or any other walling material.

Walls	External surface Temperature	Internal surface Temperature	Difference
East	-	-	-
West	30.0	29.7	0.3
North	28.7	28.6	0.1
South	30.3	28.8	1.5

Table 12: *Comparison of External and Internal Surface Temperatures of Walls*

- The temperature readings were taken on the **top floor during daytime**
- The internal surface temperature was found to be constant throughout the house
- The earth blocks don't let heat radiate through from the external surface to the interiors of the building
- External factors such as vegetation, shading from other built mass also affect the temperature readings

Waste Segregation

Waste segregation is a mandatory practice in Auroville. Every housing society has a waste segregation system. Segregation is done using different bins for different kinds of wastes.

Waste segregation is an environment friendly practice and helps in improving the rate of recycling and reducing the cost of disposing waste.

Figure 178: *Vaulted roof*

Figure 179: *Jacked Arched Roof*

Water Harvesting and Treatment

Figure 180.1
The rainwater being collected into a small tank in Vikas Community

Figure 180.2
Garden Pool in Vikas Community

Figure 180.3
Rainwater storage tank with pump room in Vikas Community

Figure 180.4
Lagooning waste water treatment in Vikas Community

Figure 180: *Water Harvesting & Treatment*

SANGAMAM – ANUPAMA KUNDOO

Auroville

Figure 181: *Front Facade: Sangamam*

Walling Material

- Soil from the site has been laboratory-tested and found to be suitable for the construction of load bearing walls
- The age-old **Rammed earth** building technique is introduced in a more sophisticated form with cement stabilisation to achieve better standard of finish, more strength and water-resistance, and enabling a quicker modular method of building
- Five per cent of cement is added in the sieved earth to make the mass water-resistant, thereby significantly adding to the wet compressive strength of the material

Figure 182.1

Figure 182.2

Figure 182: *Rammed Earth Building Technique as Walling Material*

Walls	External surface Temperature	Internal surface Temperature	Difference
East	31.5	30.5	1.5
West	35.9	30.5	5.4
North	32.1	30.5	1.6
South	31.5	30.5	1

Table 13: *Temperature Variation Between External and Internal Surfaces of Walls (Rammed Earth)*

- The temperature readings were taken during **daytime** using a **surface thermometer**
- The internal surface temperature was found to be constant throughout the house
- The external surface temperature was found to be highest on the west facing wall. However, the earth blocks don't let heat radiate through from the external surface to the interiors of the building
- Rammed earth walls helped in keeping the internal temperatures cooler

U-value = 5.679 W/m2k

Roofing

Roofs have been constructed using terracotta filler slabs, bricks as jack arches, and conical hollow vault elements designed specifically to achieve an affordable solution with low environmental impact that is beneficial to generate local employment.

Figure 183: *Vaulted roof*

Figure 184: *Jacked Arched Roof*

Red Oxide Flooring

Red Oxide Flooring is used extensively throughout Auroville.

It is very cost effective and easy to maintain when compared with other flooring alternatives. The climate of Auroville allows the Red Oxide flooring to sustain for a longer period of time.

Figure 185.1

Figure 185.2

Figure 185: *Red Oxide Flooring*

MODULE III

SERVICES AND EQUIPMENTS

This module provides guidelines and recommendations for reducing water and energy consumption in homes through the use of efficient fixtures, equipment, and sustainable practices.

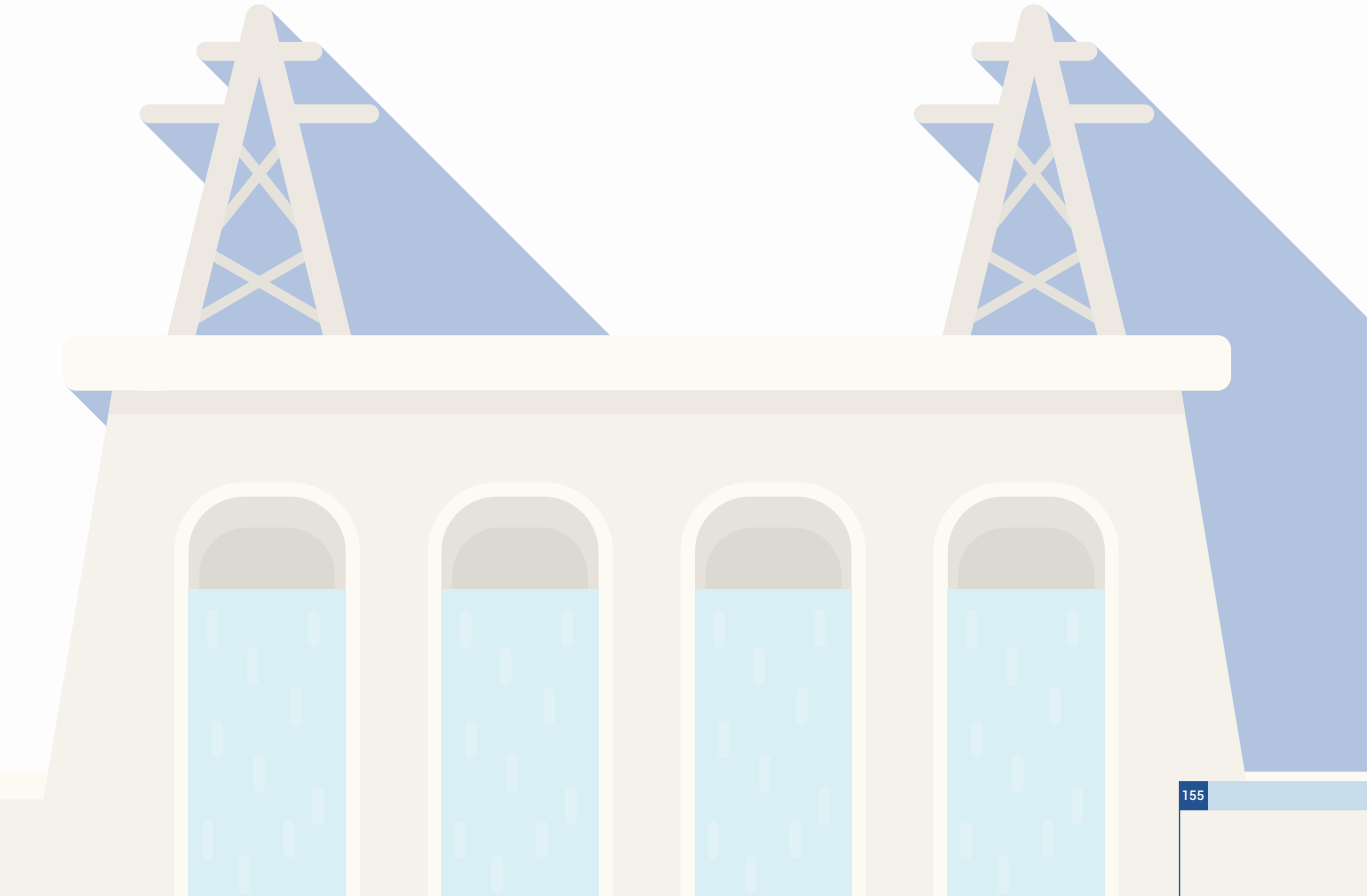
TABLE OF CONTENTS

IN THIS MODULE...

...you will explore the effective ways to maximize efficiency in your home by adopting smart fixtures, sustainable technologies, and eco-conscious practices. This module provides insights into selecting water-saving solutions such as low-flow faucets, dual-flush toilets, and rainwater harvesting systems to reduce waste and conserve resources.

You'll also learn about energy-efficient upgrades like LED lighting, solar panels, and smart thermostats that help minimize energy consumption while lowering utility bills. The module emphasizes best practices for managing daily habits, such as turning off unused appliances, leveraging natural light, and optimizing heating and cooling systems for a sustainable living.

By integrating these innovations and techniques, you can create a home that not only supports your lifestyle but also minimizes environmental impact, paving the way for a more sustainable and cost-effective future.



WATER SOLUTIONS

Water Supply and Fixtures

Our objective is to reduce the consumption of water as much as possible and to recharge the ground-water wells. Following are the methods to do so.

Hand-Held Showerheads

Install hand-held showers (instead of the overhead rain-showers) in your bathrooms for efficient use of water.

Figure 187: *Hand-held showerheads*

Figure 186: *Low- flow faucets*

Low- Flow Faucets

Use low-flow faucets. When water rushes out of the tiny holes of a low-flow faucet, air gets mixed into it by an aerator. This considerably reduces the rate of water flow as compared to the conventional taps. It also saves you money on your water bills.

NOTE: *The rate of water flow reduces from 8-10 Litres per minute to 3-5 Litres per minute!*

Dual Valve Flush Tank

Dual flush toilet systems in your home allow you to choose between two levels of flushing based on the waste that needs to be flushed. While solid waste would mostly require full flushing, liquid waste would only require half flushing.

This saves a lot of water over time. The higher initial cost of installation is recovered by the reductions in your water bills.

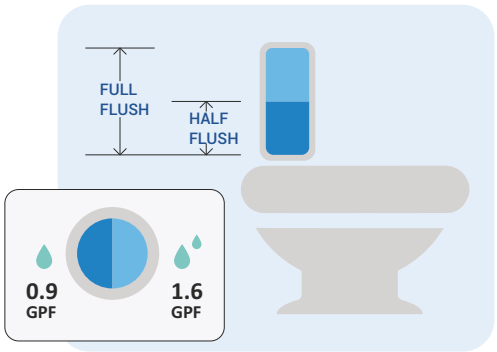


Figure 188: *Dual Valve Flush Tank*

Rain- Water Harvesting

Prevent the rainwater that falls on the terrace and balconies of your home from reaching the municipal drains. Instead, harvest it as much as possible.

There are two approaches to harvesting rainwater.

Approach 1: Rainwater Storage

If you live in a region where it rains frequently throughout the year, you need to store the rainwater and use it regularly for non-potable purposes.

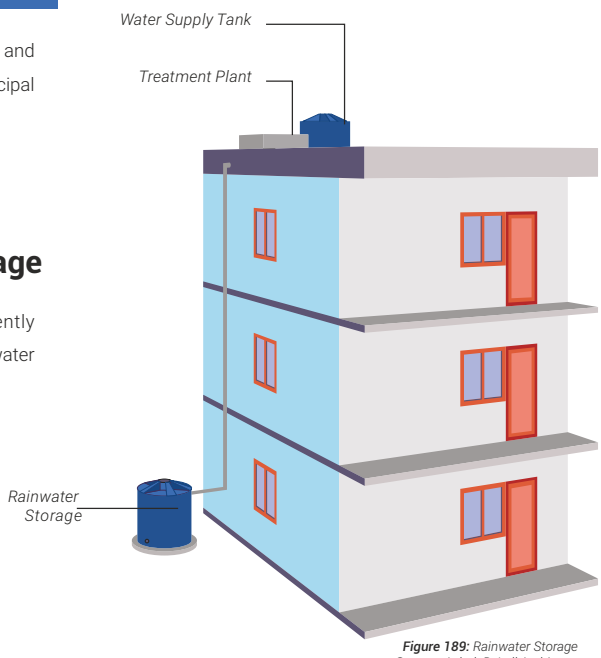


Figure 189: *Rainwater Storage*
Source: *Ashok B. Lall Architects*

Approach 2: Rainwater Recharge

If you live in a region where it rains only in the limited monsoon seasons, you need to lead the rainwater to groundwater recharge.

This way, the water gets filtered as it passes through the different layers of the ground and helps maintain the groundwater levels.

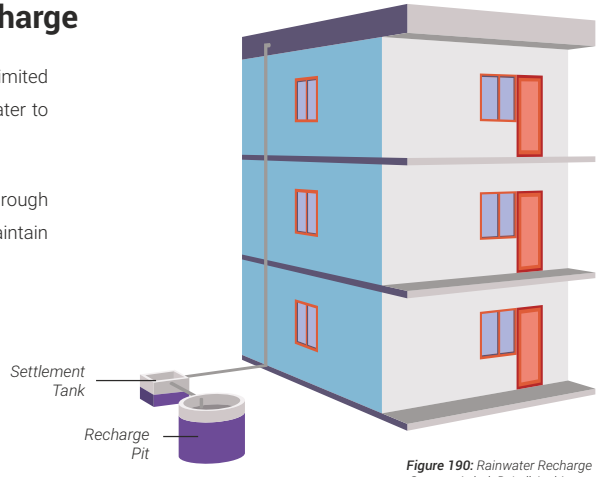


Figure 190: *Rainwater Recharge*
Source: *Ashok B. Lall Architects*

ENERGY SOLUTIONS

Electrical Fittings and Fixtures

Products with a star rating of less than 3, should be avoided. Products with the maximum star rating of 5 can be costlier, but they offer very good savings in the long run.

When buying electrical fittings and appliances for your home, make sure to look for the star rating labels on the products. These ratings are given by the Bureau of Energy Efficiency. More the number of stars, more is the energy saving, and thus, more is the saving on your electricity bills.

The standards and labelling program by the Bureau of Energy Efficiency not only rates appliances based on their energy efficiency, but also takes into consideration, the cost saving potential of these appliances.

So, if you have the budget to spend a little extra at the time of buying, you should buy the highest star rated appliances possible.

Refer to the BEE website to know more about this.

https://beeindia.gov.in/en/standards-labeling.

Led Tubelights

Select an LED Tubelight with a Power Range between 18-22 Watts.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Led Bulbs

Select an LED Bulb with a Power Range between 6-9 Watts.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Ceiling Fans

Select a ceiling fan with a Power Range between 35-50 Watts. Look for BLDC Motor fans for both, ceiling fans and exhaust fans.These fans consume about half the electricity when compared to the normal fans. They do not generate heat and a humming noise.

Star rating range to look for:

★ ★ ★ ★ ★

NOTE: As of April 2024, BEE has not released their star ratings for exhaust fans. Look out for Exhaust fans with BEE star rating of 3-5 if and when they are available.

Geyser

Select a Geyser with a capacity between 15-25 litres.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Solar Photovoltaic System

Installing a Solar PV System on the terrace of your home takes care of a portion of your electricity demand without any recurring cost.

Depending on the capacity of the system installed, electrcity bills get reduced.

If a Battery- Inverter system is connected to the Solar PV, you also get electricity during power outages.

Solar Water Heater

Most of your hot water needs can be met by installing a solar water heater. It directly uses the heat of the sun to heat up the water and does not use electricity. For cold weather, a combination of this and the regular geyser works best to compensate for cloudy days.

NOTE: *Solar water heaters are ideal to be used for single family, stand-alone homes. For multi-family houses, the pipelines get too complicated. It is then best to connect your regular geysers to the electricity supply from Solar PV.*

Home Appliances

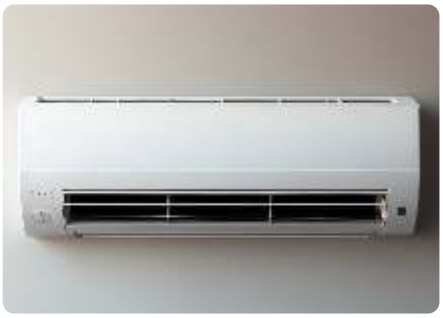
Split AC

Select a split AC of 1-1.5 tons. Split ACs are generally more efficient than window ACs and they do not compromise the windows which are essential for daylight and natural ventilation.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

NOTE: Ensure annual maintenance of your air conditioners for their proper working and long life.



Gas Stove

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Television

Select an LED backlit TV as they are highly energy efficient. LCD screens have become widely avaiable at cheap prices.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Refrigerator

Select a single door refrigerator (which has its freezer unit on top) or a double door refrigerator with a top-mounted freezer.

Star rating range to look for:

★ ★ ★ to ★ ★ ★ ★ ★

Washing Machine

Compare water consumption while buying a washing machine.

Star rating range to look for:

★ ★ ★ ★ ★

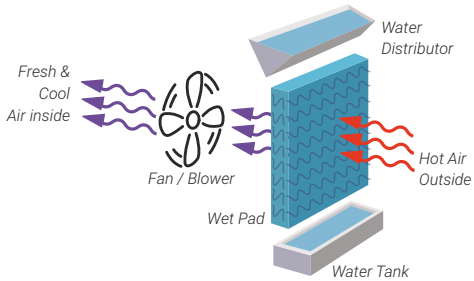


Figure 191: *Desert Cooler*
Source: *Ashok B. Lall Architects*

Desert Cooler

Install a Desert Cooler in your home for improved indoor comfort and reduced electricity requirement.

When the hot and dry outdoor air passes through a wet pad, the cool water from the pad absorbs heat from the air and evaporates. In this process, the passing air cools down. This cooled down air is then passed through the interior spaces using a fan.

Note: *A desert cooler will not work in humid climatic regions or weather conditions.*

Advantages

- It is much cheaper than Air Conditioning
- It uses 1/10 of the electricity used by an AC
- Air from a desert cooler is moist and comfortable. Whereas, air-conditioning causes dryness

Do not place cooler inside the room

Two ways a cooler can work

1. **A fan is integrated in the cooler system and it throws the cool air with pressure into the room.**

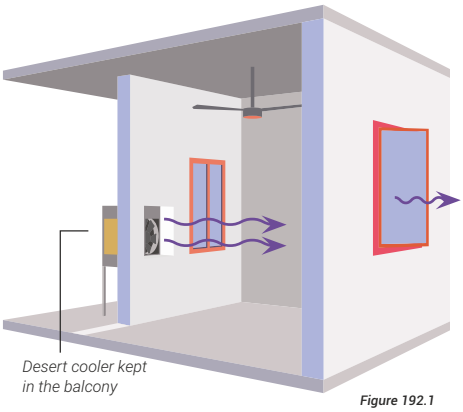


Figure 192.1

Windows at other parts of the home are slightly opened for cross- vetilation.

Proper functioning of a cooler requires dry air to pass through it so that it can be cooled by the absorbed moisture.

A cooler placed inside the room is most inefficient. It circulates the same air through the wet pad again and again. The air becomes so humid that cooling stops.

Therefore, place your cooler outdoors, with an opening in the wall that allows air from it to enter the room.

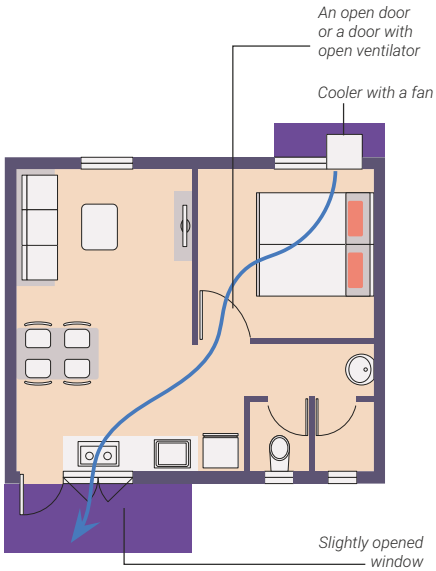


Figure 192.2

PROS:

- This model is readily available in the market.
- It is efficient in cooling large spaces

CONS:

- It sends in a blast of air, which may be uncomfortable for the user.
- It creates a lot of noise.

Source: *Ashok B. Lall Architects*

2. **The cooler does not have an integrated fan. An exhaust fan, located at the other end of the room creates a vacuum by sucking out the room air. This causes air from outside to pass through the wet pads of the cooler, into the room.**

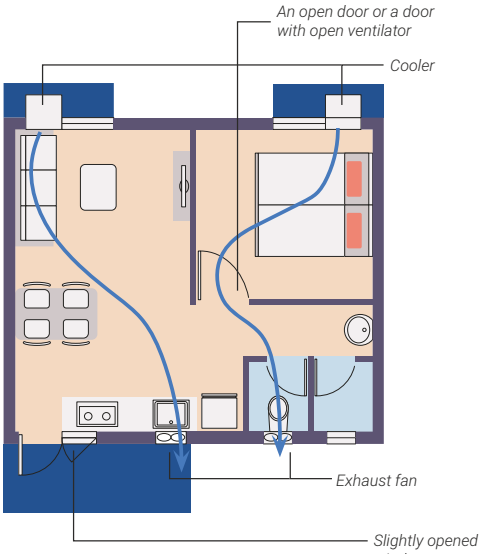


Figure 192.4

Figure 192: *Air-circulation in the building*
Source: *Ashok B. Lall Architects*

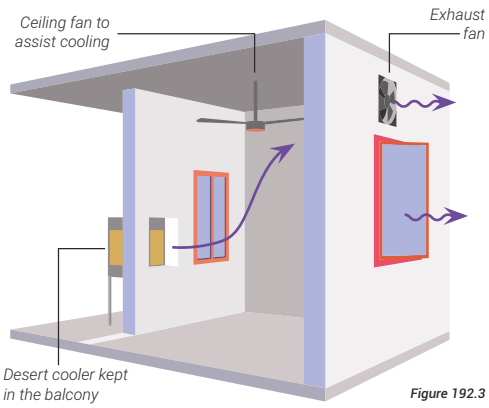


Figure 192.3

Windows at other parts of the home are slightly opened for cross ventilation. Ceiling fans are required to ensure proper cooling.

PROS:
- This method gets rid of the usual blast that is experienced in conventional coolers. Air is blown in like a soft breeze
- Noise is minimal, as it is only emitted by the exhaust fan

CONS:
- It is an innovation that needs to be installed by the initiative of the user/ owner

Covering the cooler opening in winters

In winters, the wall opening for the cooler lets in chilled air, which needs to be shut out.

OPTION 1

Installing 180 degrees opening shutters

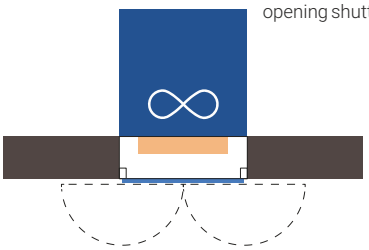


Figure 193: *Openable Shutters*
Source: *Ashok B. Lall Architects*

OPTION 2

Installing a louvered shutter which can be adjusted to be fully closed when required

Figure 194: *Horizontal Louvers*
Source: *Ashok B. Lall Architects*

EV Charging Points

With the eventual mainstreaming of electric vehicles, it is necessary to provide their charging points in parking areas (whether stilted or not).

EV charging points not only contribute towards a 'green home', but a 'green lifestyle'.

Figure 195: *EV Charging Point*
Source: *Adobe Stock Image*

Metering For Multi- Family Homes

Electricity and water are precious resources and will become scarce and expensive in the future.

Each home must pay and be responsible for their own consumption in the home.

Therefore, provide separately metered connections for electricity and water supply to each dwelling unit in a building.

For shared areas, provide separate metering for both electricity and water supply to equally divide the bills among the residents.

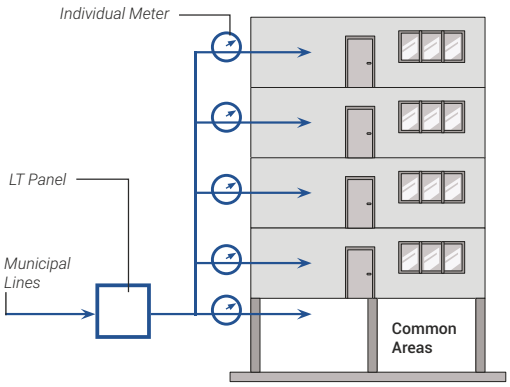


Figure 196: *Electricity Supply*

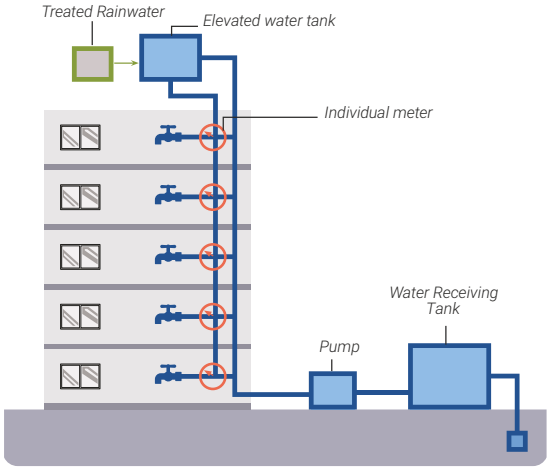


Figure 197: *Water Supply*
Source: *Ashok B. Lall Architects*

Motion Sensors and Solar Lamps

For Shared Areas

Source: *Adobe Stock Image*

For outdoor lighting, install solar lamps. These have no recurring cost and can also be installed in conjunction with motion sensors to ensure that the lamps are sufficiently charged when needed.

Source: *Freepik*

For common areas such as parking and staircases, install lights that work in conjunction with motion sensors.

Since, it is a shared expense, motion sensors ensure that there is no wastage of electricity.

Quiz Time!

1. Desert cooler works best in which of the following climatic conditions?

a Hot and Dry
b Warm and Humid
c Cold and dry
d Arid

2. Which of the following ratings for appliances is the most energy efficient?

a 1 Star
b 2 Star
c 3 Star
d 5 Star

2. What star rating should ceiling fans have for high efficiency?

a BEE-2 Star
b BEE-3 Star
c BEE-4 Star
d BEE-5 Star

2. Which of the following is an energy-efficient lighting option?

a CFL bulbs
b Incandescent bulbs
c LED bulbs
d Halogen bulbs

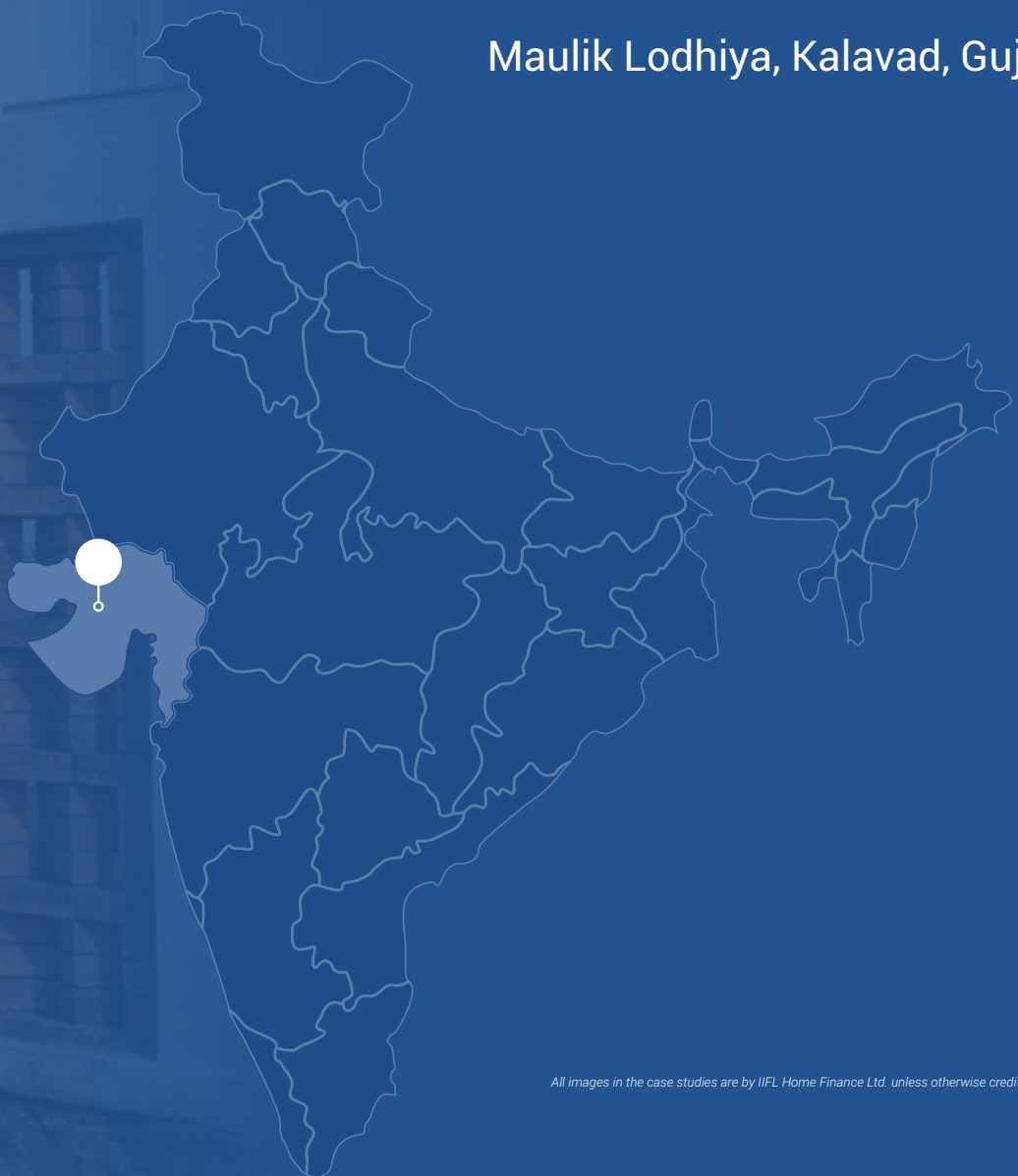
GLOSSARY

Dual-Flush Toilet System	A toilet that allows users to choose between two flushing options: a full flush for solid waste and a reduced flush (half flush) for liquid waste, significantly conserving water.
Low-Flow Faucet	A faucet designed to reduce water flow while maintaining pressure, often using an aerator to mix air with water, resulting in lower water consumption.
Rainwater Harvesting	The practice of collecting and storing rainwater from rooftops or other surfaces for non-potable uses, such as irrigation or toilet flushing or groundwater recharge.
LED Tubelight	An energy-efficient lighting option that uses light-emitting diodes (LEDs) instead of traditional incandescent bulbs, offering longer life and reduced electricity consumption.
Solar PV System	A system that converts sunlight into electricity using photovoltaic panels, helping reduce reliance on grid power and lowering electricity bills.
Desert Cooler	An evaporative cooling system that uses water to cool air, making it suitable for hot and dry climates while consuming significantly less electricity than traditional air conditioning.
Motion Sensors	Devices that detect movement and can automatically turn lights on or off, contributing to energy savings by ensuring lights are only used when needed.
EV Charging Point	A designated area equipped with charging infrastructure for electric vehicles, promoting the use of green transportation solutions.
Bureau of Energy Efficiency (BEE)	An agency set up by GoI to promote energy efficiency and conservation across various sectors in the country. It aims to aims to reduce energy consumption, enhance energy performance, and promote the use of energy-efficient technologies.
Star Rating System	A rating system that indicates the energy efficiency of appliances; higher star ratings correspond to greater energy savings.
Individual Metering	The practice of installing separate meters for each unit in a multi-family building to track individual consumption of electricity and water, promoting accountability among residents.
Solar Water Heater	A system that uses solar energy to heat water for domestic use, reducing reliance on conventional electric geysers.

LT Panel (Low Tension Panel)	An electrical distribution board that receives power from a transformer or generator and distributes it to various loads at a low voltage, It ensures safe and efficient power distribution, protection, and control of electrical circuits.
Green Lifestyle	A way of living that minimizes environmental impact by adopting sustainable practices such as energy conservation, waste reduction, use of eco-friendly products, and making conscious choices in housing, transportation, and daily activities to reduce carbon footprint.

CASE STUDY
BUTTERFLY HOUSE

Maulik Lodhiya, Kalavad, Gujarat



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BUTTERFLY HOUSE MAULIK LODHIYA, KALAVAD, GUJARAT

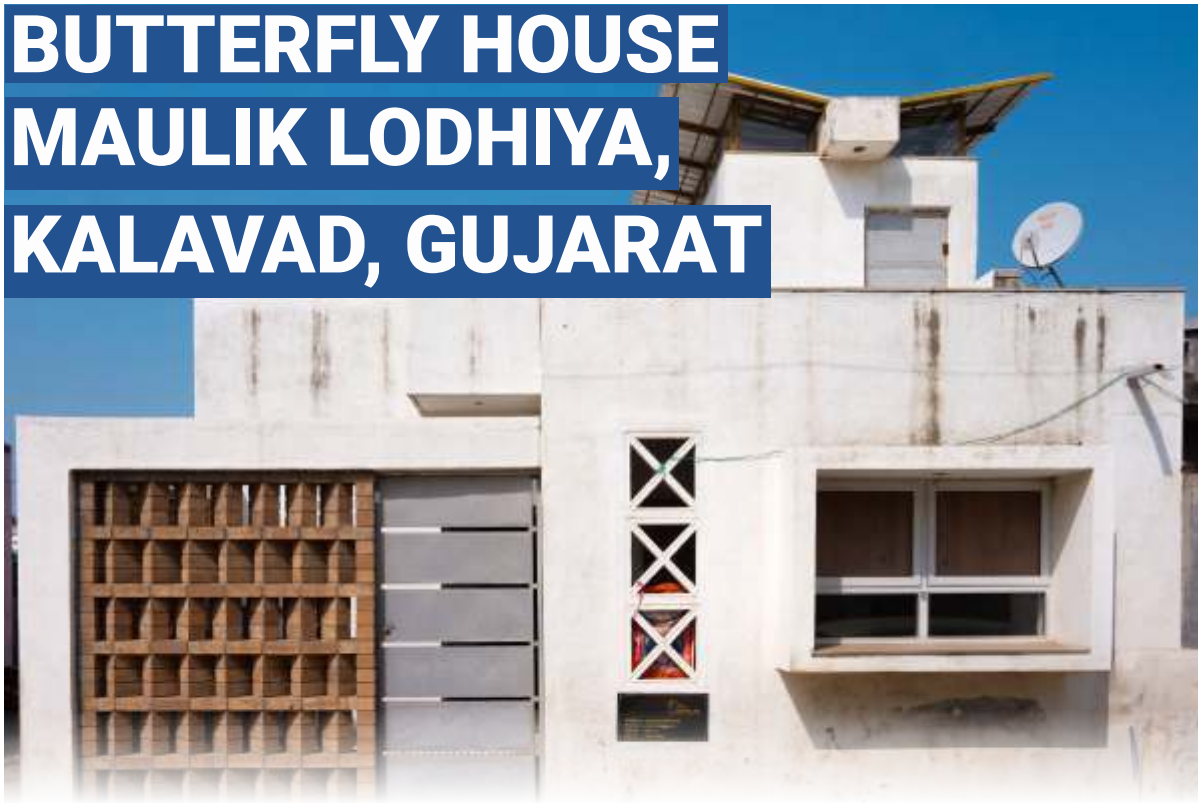


Figure 198: *Butterfly House*

Location & Geography

- The site is located in Kalavad, Gujarat
- Kalavad comes under the Jamnagar District and is 50kms away from Rajkot
- The soil in this region is clayey and silty
- The local construction in this region features the use of Bela Stone. This is a local stone which is mostly used in the construction of walls
- The climate type in this zone is Semi Arid

Figure 199: *Kalavad, Gujrat.*

Spatial Planning

- The Architect has placed both the bathrooms of the house on the western edge of the plot and the kitchen and verandah on the eastern edge
- This creates a buffer between the services and the living spaces
- This buffer helps in reducing the amount of heat in the living space creating a comfortable environment indoors

Figure 200: *Kitchen on the eastern edge*

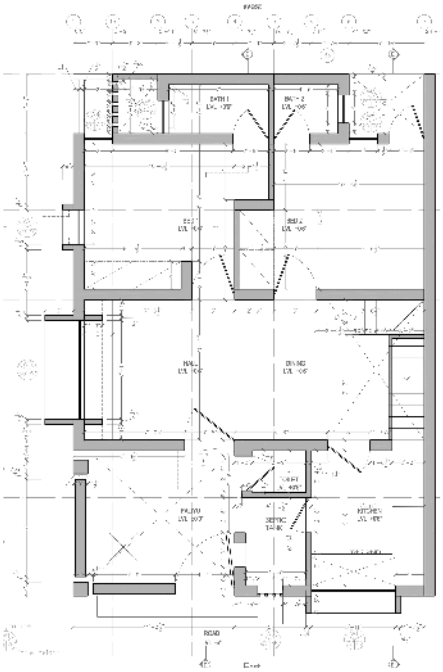


Figure 201: *Key plan*

Walling Material

The Architect has used Bela Stone as the walling material in the house.

This is a locally available stone in the region of Junagad and hence it is cheaper than the red brick.

"One block of Bela stone can replace 9 bricks. This helps in less usage of mortar and time making it a cost effective alternate for red brick" - **Maulik Lodhiya.**

Figure 202: *Construction with Bela Stone in Progress*

Walls	Bela Stone	Red Brick	AAC Block
Cost	₹30-35 per Block	₹9-10 per Block	₹6-7 per Block
Size	9x15x7 in	9x4x3 in	12x4x2 in

Table 14: *Comparison of Wall Construction Materials by Cost and Size*

Skylight

The roof of the Mumty has a skylight built into it. It has a beam in the center to collect water from the slanted sheds.

The walls of the mumpty are painted white. The skylight serves the following purpose:

- It helps in letting in natural light during the day-time. This creates an ambient atmosphere inside the home which reduces the usage of artificial lighting
- The vents in the skylight help hot air escape from the living space, while the skylight above the staircase also introduces stack effect inside the house

Figure 203: *Skylight on Kitchen's roof*

Figure 204: *Skylight in the roof*

Figure 205: *Slanted sheds featuring water collection in the beam*

Figure 206: *Skylight above the staircase*

Flooring

Kota stone has been used as the flooring material in the house. Kota stone, produced in the neighboring state of Rajasthan is easily available throughout Gujarat.

"Although the cost of Kota stone is slightly more than tiles, the embodied energy of the stone is less making it a more sustainable choice over floor tiles" - **Maulik Lodhiya**

The architect has used white reflective tiles on the roof. The surface of these tiles help in reflecting the harsh sunlight hitiing on the roof keeping the inside cooler.

Figure 207: *Bulk lot of Broken Tiles*

Figure 208: *Kota stones in the verandah*

Figure 209: *White reflective tiles*

The flooring on the outer veranda is done using a waste of Italian marble from a different construction site the architect was working on.

Window Overhangs

- The windows on the Southern and Western Facades have used Overhangs whose depth is greater than 1.5 feet
- These overhangs make sure that the harsh sunlight is diffused before it enters the house
- The overhangs help in keeping the interiors of the home cooler

Figure 210: *Window overhang with 1.5' depth*

Plaster

- The plaster comprises of unutilized waste sand
- The fine particles from the sand are used to make the mortar for laying building blocks
- The large particles left unfiltered are used in the external plaster for the building
- These bigger particles of sand creates a self shading effect on the wall

Figure 211.1

Figure 211.2

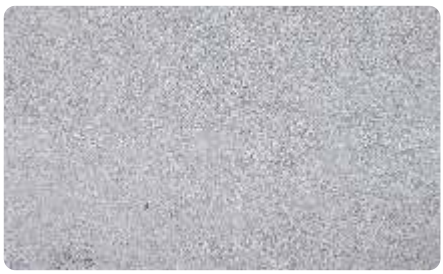


Figure 211.3

Figure 211: *White paint over the plaster*

Brick Jaali

The architect has created a Jaali pattern on the corner of the south-western facade of the house. This helps in:

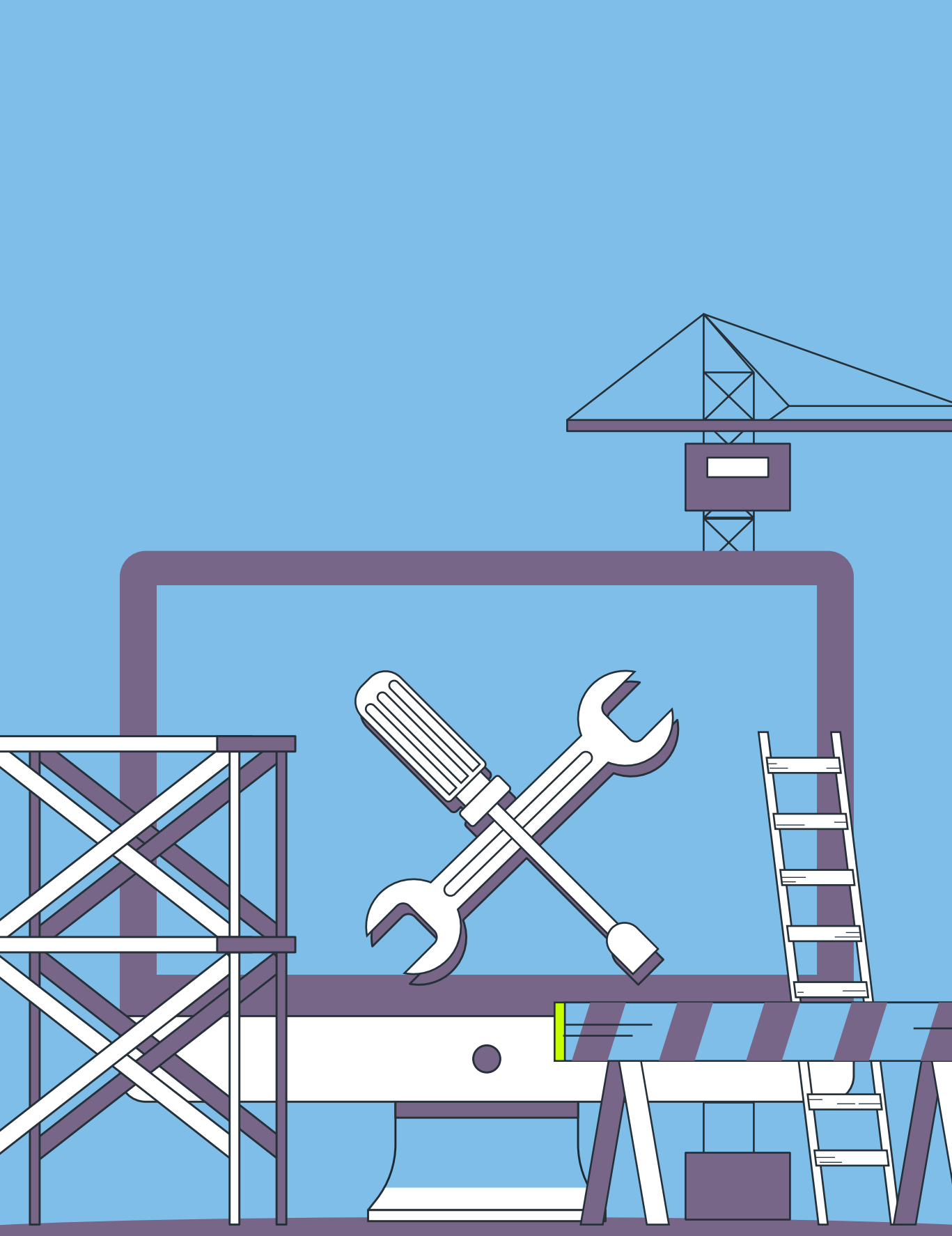
- Buffering the living areas from the harsh sun on west and south-west sides
- Shading the outer veranda of the house making it a habitable space
- Acting as a visual buffer to the main street

This was made using the locally found Fire Clay Bricks which costed at around ₹11 per Brick.

Figure 212: *South Western Corner Wall with Brick Jaali*

TOTAL COST - 8LAKHS

Maulik Lodhiya, Kalavad, Gujarat



MODULE IV

MAINTENANCE MANUAL

This guide provides essential tips on maintaining your home's longevity and ensuring its efficiency through sustainable upkeep and preventive care.

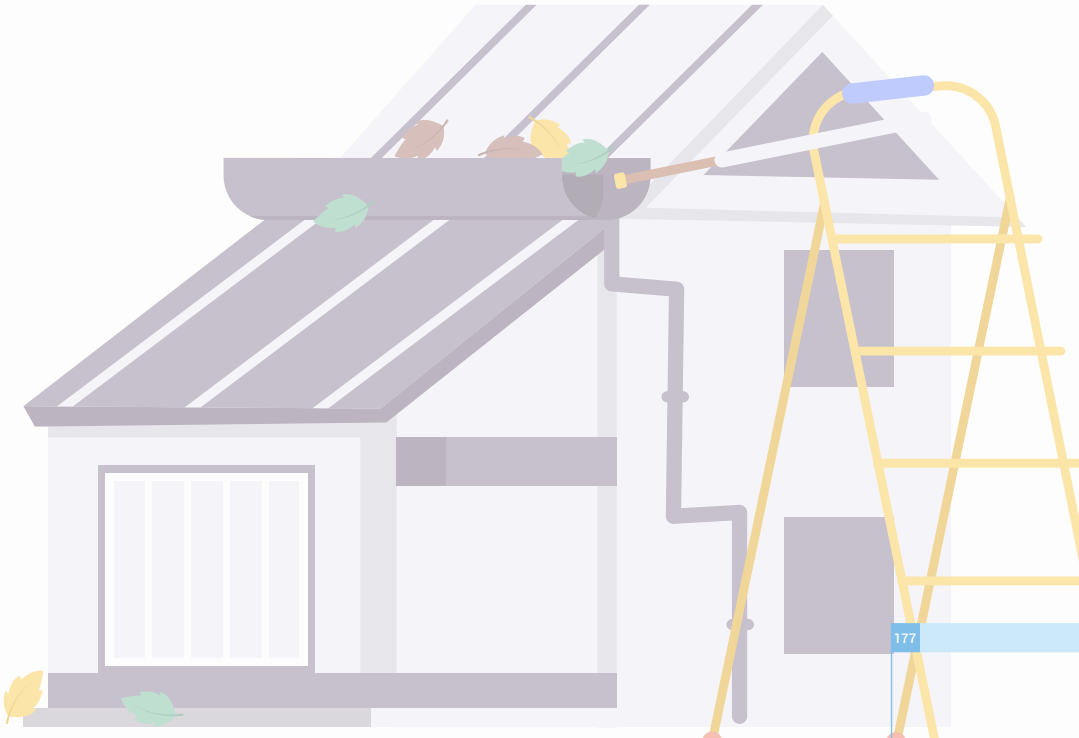
TABLE OF CONTENTS

IN THIS MODULE...

...you will learn how to preserve your home's durability and functionality through mindful and sustainable practices. This module focuses on equipping you with the knowledge to maintain your home efficiently while reducing its environmental footprint. Key topics include adopting preventive maintenance techniques to identify and resolve issues early, selecting eco-friendly materials that promote sustainability, and implementing energy and water conservation measures.

You will also explore the importance of regular maintenance schedules, such as inspecting for wear and tear, sealing leaks, and ensuring proper ventilation to prevent long-term damage. The module emphasizes sustainable practices like upgrading to energy-efficient appliances, using non-toxic cleaning solutions, and managing waste responsibly.

By applying these strategies, you can reduce maintenance costs, enhance your home's resilience against environmental challenges, and create a healthier living environment for your family. Ultimately, this module guides you toward achieving a balance between maintaining a comfortable home and contributing to a sustainable future.



INTRODUCTION

Ensuring the longevity and efficiency of a home goes beyond construction—it requires ongoing care and maintenance. By selecting sustainable materials like those that improve insulation and waterproofing, homeowners can enhance a building's performance and durability over time. Effective waste management and recycling practices further reduce a home's environmental footprint, making the upkeep process more eco-friendly Efficient systems for water, energy, and waste management, along with durable materials, ensure that homes remain functional and sustainable for years. This comprehensive approach to maintenance helps homeowners sustain the benefits of their eco-friendly investment, keeping homes both cost-effective and environmentally responsible.

WHY & HOW TO MAINTAIN YOUR BUILDING?

To have an extended life of your home, it is important that the materials used in its construction and the systems and fixtures installed in it, are properly maintained. "Empty homes decay faster"; this is precisely because there is no one to look after them.

The maintenance of any building involves three aspects:

1. **Using Design Materials, Fixtures and Finishes**

2. **Preventive Maintenance**

3. **Maintenance of Shared Services**

Figure 213: *Fresh painting in progress*
Source: *Freepik*

Using Design, Materials, Fixtures & Finishes That Require Least Maintenance

While building and furnishing your home, make sure that you choose the right materials and fittings so that you do not have to be worried later.

Consider the level of maintenance required by anything you choose for your home.

Here are some examples:

Adequate Waterproofing

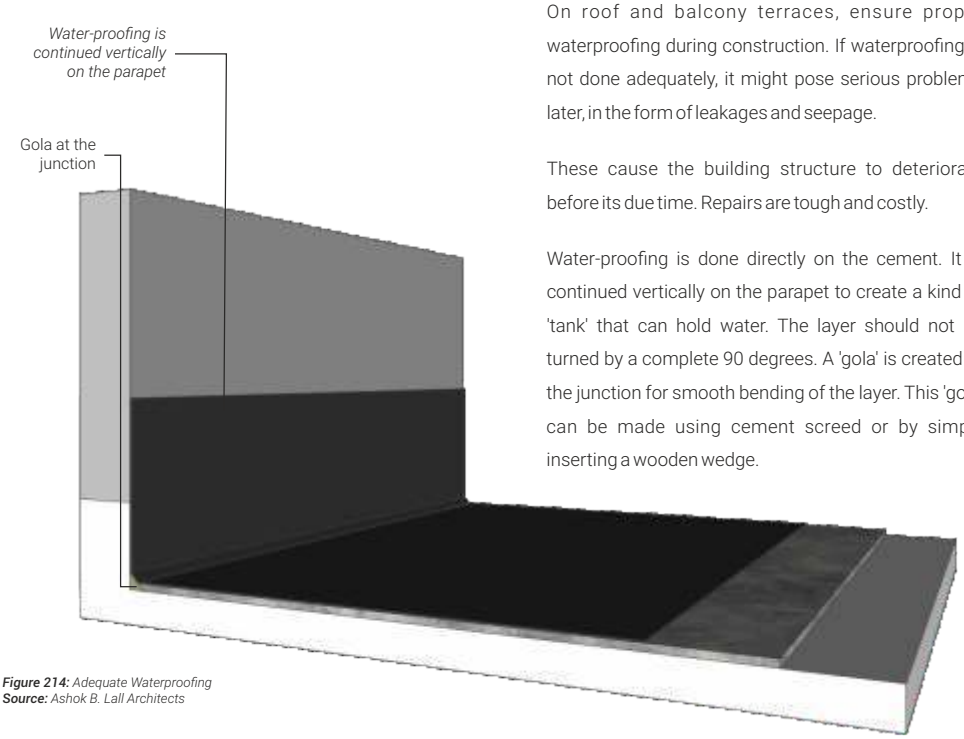


Figure 214: *Adequate Waterproofing*
Source: *Ashok B. Lall Architects*

On roof and balcony terraces, ensure proper waterproofing during construction. If waterproofing is not done adequately, it might pose serious problems later, in the form of leakages and seepage.

These cause the building structure to deteriorate before its due time. Repairs are tough and costly.

Water-proofing is done directly on the cement. It is continued vertically on the parapet to create a kind of 'tank' that can hold water. The layer should not be turned by a complete 90 degrees. A 'gola' is created at the junction for smooth bending of the layer. This 'gola' can be made using cement screed or by simply inserting a wooden wedge.

Tiles- Ceramic/Vitrified Tiles for Wet Areas

For bathroom flooring and walls (at least upto a height of 7'), kitchen flooring and walls above the countertop, choose ceramic/ vitrified tiles.

They are water-proof and easy to clean, which is important for your health and hygiene.

Also, ensure that the flooring tiles are sturdy and non-slip.

Figure 215: *ceramic tiles in the bathroom*
Source: *Freepik*

Roof- White Tiles on Roof

To reflect the sun's rays falling on the roof, you can either choose to paint it white or put tiles on it. But tiles are a better option as they are practically maintenance free.

You can either put raw tiles purchased from the market, or use waste broken tiles for china mosaic flooring.

Figure 216: *China Mosaic*
Source: *Freepik*

Figure 217: *Vitrified tiles in kitchen counter*
Source: *Freepik*

Railing- Vertical Railing Designs

Railings that are made of vertical members instead of horizontal ones, not only collect lesser dust on them, but also ensure childrens' safety.

Figure 218: *Vertical railing design*
Source: *Adobe Stock Image*

Windows- Friction Type Hinges for Windows

Install friction type hinges for your windows. These hinges open the windows in a way that allows easy cleaning of the outside glass surface while standing inside the room.

Figure 219: *Top-Hung Window Hinge*
Source: *amazon*

Figure 220: *Casement window with side hung hinge*
Source: *Adobe Stock Image*

Walls- Plastering

When using walling materials such as CSEB and AAC blocks, external cement plastering should be done to prevent moisture from entering the walls.

Figure 221: *Plastering in progress*
Source: *N.Srinivasa, 2019*

Steel- Enamel Paint on Steel

To prevent the weathering and corrosion of steel used for railings and shading screens, the steel members should be coated with good enamel paint.

Figure 222: *Steel being coated with enamel paint*
Source: *Adobe Stock Image*

Water Closet- Wall Hanging Water Closet

Installing a wall hanging WCin your toilet allows better cleaning of the toilet floor than the floor installed WC.

Figure 223: *Wall Hung WC (Aquant India)*
Source: *Adobe Stock Image*

Kitchen- Sink with Rounded Corners

Choose a kitchen sink that has rounded corners instead of going with the trend of installing sharp corners. It is easier to clean the sinks with round corners.

Figure 224: *Radius corners Kitchen Sink*
Source: *Adobe Stock Image*

Preventative Maintenance

Even though you have now chosen materials and equipments that require least maintenance, there would always be some or the other part of your home that needs to be taken care of on a regular basis. In such cases, you should ensure 'preventive maintenance'.

This implies that you take regular care of materials and equipments before they are on the verge of getting damaged. This prevents any further damages that may be caused while repair.

Here are some examples:

Solar Panels: Regular Cleaning of Solar Panels

To maintain the efficiency of solar panels, the surface should be kept clean.

The sloped installation of solar panels ensures that they automatically get cleaned in rainy season.

For the rest of the year, you have to clean these yourself about every 2 weeks.

Figure 225: *Cleaning of Solar Panels*
Source: *Adobe Stock Image*

Wood: Maintenance of External Wood

Wood that is exposed to the external environment, mainly in doors and windows, should be repainted regularly (about every 2-3 years) to keep it protected from wear and tear.

Figure 226: *Priming the wood surface*
Source: *Freepik*

Roof: Re-application of White Paint on Roof

As suggested above, putting white tiles on your roof is a better option as against painting the roof white because they dont require maintenance.

however If, you choose to paint your roof white, it is important that you re-apply the white paint every 5 years. This is because the paint is bound to get dirty over time, and therefore reduce its reflectivity.

Figure 227: *Waterproofing paint for the roof*
Source: *BBC*

Warranties & Annual Maintenance Contracts

While buying various appliances for your home, check for warranties and ensure that you have their details.

You can also bargain for availing an Annual Maintenance Contract (AMC) for appliances that require regular maintenance like Washing Machine and Water Purifier.

For a long life and assured performance of such products, it is advisable for a technical person to inspect and undertake preventive maintenance once every 6 months.

5 reasons why you should have an Annual Maintenance Contract

1. Emergency support when you need it
2. Expert technicians at your disposal
3. Save money and make budgeting easier
4. Get more out of you hardware or facilities.
5. Focus on other things and leave maintenance to the pros

Maintenance Task	Interval
Cleaning solar panels	2 weeks
Servicing water prifier	6 months
Servicing air conditioner	1 year
Repainting/ Oiling external wood	2-3 years
Re-application of white paint on roof	5 years

Table 15: *Routine maintenance task and intervals*
Source: *Ashok B. Lall Architects*

Maintenance of Shared Services

As proposed in this handbook, all type designs are capable of vertical expansion in such a way that each floor can be used by a different owner.

When the same building is used by multiple owners, there are some areas and services that are shared amongst all.

Shared areas are- Stilted parking floor, Staircase, Boundary walls, Courtyards and Roof in some cases.

Shared services are- Solar PV, Common water tanks and pipelines.

These shared areas and services often go unattended because no single owner is responsible for their upkeep.

Therefore, ensure that a 'Building Secretary' is appointed by mutual understanding of all the residents, who is then accountable for the maintenance of all the shared areas and services.

The Building secretary should make sure that the solar panels and common water tanks are regularly cleaned and the pipelines regularly checked for any leakage.

They should collect a maintenance fee from all the owners to pay for the upkeep and cleaning of all the common areas.

Also, electricity and water supply to common areas should be seperately metered and evenly shared among all owners.

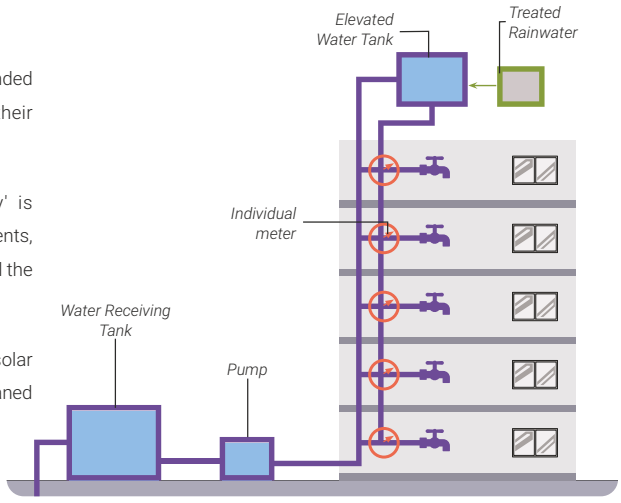


Figure 228: *Water Supply*
Source: *Ashok B. Lall Architects*

Quiz Time!

1. What type of railing design is recommended for better safety and easier cleaning?

   a. Horizontal railing design
   b. Vertical railing design
   c. Curved railing design
   d. Glass railing design

2. How often should white paint on a roof be re-applied to maintain its reflectivity?

   a. Every year
   b. Every 5 years
   c. Every 10 years
   d. Every 2 years

3. Which material is recommended for bathroom flooring to ensure it is water-proof and easy to clean?

   a. Granite tiles
   b. Wooden flooring
   c. Curved railing design
   d. Marble tiles

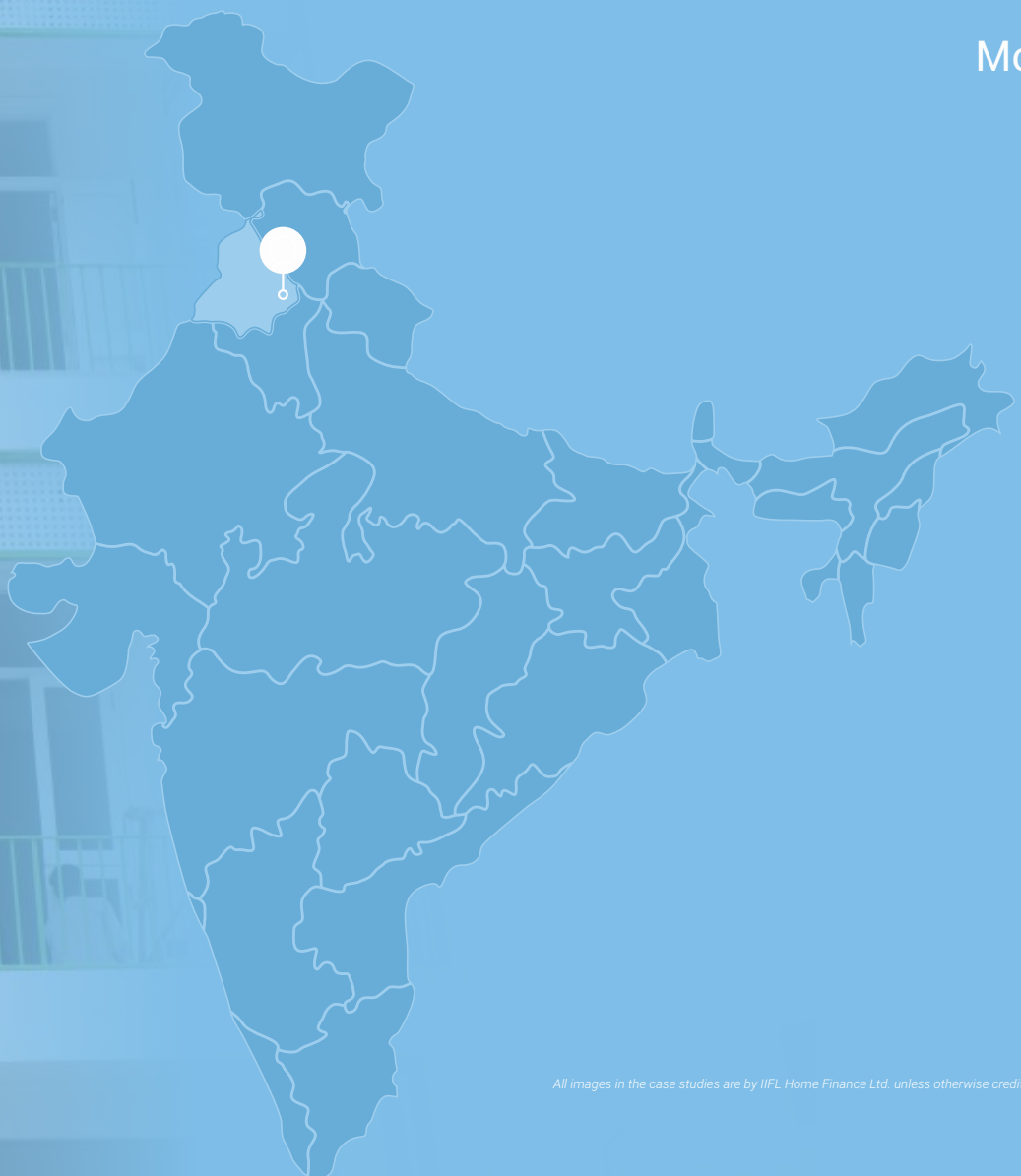
GLOSSARY

Precast Ferrocement Channel Roof	A roofing system essentially prefabricated, cylindrical shell units that are made of thin reinforced concrete channels manufactured off-site known for light-weight, durable and versatile.
Waterproofing	A technique to make a surface resistant to water penetration, crucial for preventing leaks and structural damage in buildings.
Gola	A curved or beveled joint between horizontal and vertical surfaces (e.g., roof and parapet) to ensure seamless waterproofing.
Ceramic/Vitrified Tiles	Vitrified tiles are ceramic tiles that are made by fusing clay, silica, quartz, and feldspar together at high temperatures. They are used on walls and floors often in high traffic areas. They are also used in kitchen and bathroom due to resistant to water and frost.
Friction Hinges	A friction hinge provides resistance to the pivoting motion of a hinge, allowing it to control or hold the movement of objects as they open and close.
Enamel Paint	A hard, glossy coating applied to steel or other surfaces to protect against corrosion and weathering known for its durability and resistance to stains and moisture.
Wall-Hanging Water Closet (WC)	A type of toilet mounted on the wall, leaving the floor beneath it clear for easier cleaning.
Solar Panels	Panel designed to absorb the sun's rays and convert sunlight into electricity, requiring periodic cleaning for optimal efficiency.
Preventive Maintenance	Regular upkeep of materials and equipment to avoid deterioration or damage, ensuring long-term performance.
Annual Maintenance Contract (AMC)	A service agreement for routine maintenance and repair of appliances or systems like washing machines or water purifiers.
Vertical Expansion	The capability of a building design to add additional floors while maintaining structural integrity.
Shared Services	Common utilities or systems used by multiple owners in a building, such as solar panels, water tanks, or pipelines.
China Mosaic Flooring	A durable and decorative flooring technique using waste broken tiles arranged into patterns, commonly used for rooftops.
Maintenance Task Interval	The recommended frequency at which specific maintenance tasks (e.g., repainting, cleaning) should be performed.

CASE STUDY

NET ZERO HOUSING

Mohali



All images in the case studies are by IIFL Home Finance Ltd. unless otherwise credited.

NET ZERO HOUSING, MOHALI, PUNJAB

Figure 229: *Net Zero Housing*
Source: *Ashok B. Lall Architects*

- The ***Net Zero Carbon Affordable Home*** (Pilot project) situated in Mohali, Punjab, is an innovative residential undertaking created by Ashok B Lall Architects and spearheaded by Jaspreet Singh Brar
- Constructed on a **334.45 m^2 plot in sector 109 of Mohali**, Punjab, this project aims to address the housing needs of the low-income group by offering affordable and low-cost housing options
- Designed to minimize its carbon footprint, the project follows a net-zero carbon approach, prioritizing sustainability and environmental consciousness

Figure 230: *Front Facade, Net Zero Housing*
Source: *Ashok B. Lall Architects*

- With a total built-up area of **477 m^2,** the development incorporates five dwelling units, each offering a carpet area of 45m^2. These units are specifically designed for the lower-income group (LIG) to ensure accessibility and affordability

Figure 231: *Balcony shading system, Net Zero Housing*
Source: *Ashok B. Lall Architects*

Location and Climate

- The proposed site is in sector 109, Mohali, Punjab
- The proposed project is located in composite climate with average annual maximum temperature of 31.5 degrees
- The hottest month of the year in Mohali is June, with an average high of 40°C and low of 28°C
- The coldest month of the year in Mohali is January, with an average low of 9°C and high of 20°C
- Mohali experiences extreme seasonal variation in monthly rainfall. The month with the most rain in Mohali is July, with an average rainfall of 204 millimetres
- The month with the least rain in Mohali is November, with an average rainfall of 5 millimetres

Figure 232: *Mohali, Punjab*

Spatial Planning

- The spatial planning of the building is done in a very simple manner. The Ground Floor consists of stilt parking along with a 2BHK apartment
- The staircase has been kept in the middle of the layout with two courtyards on both the ends
- These courtyards ensure that the building is ventilated with ample amount of sunlight and air throughout the day
- The first and second floor consists of two 2BHK apartments. The placement of the openings in these apartments are in coordination with the central courtyard which ensures that the apartments receive cross ventilation

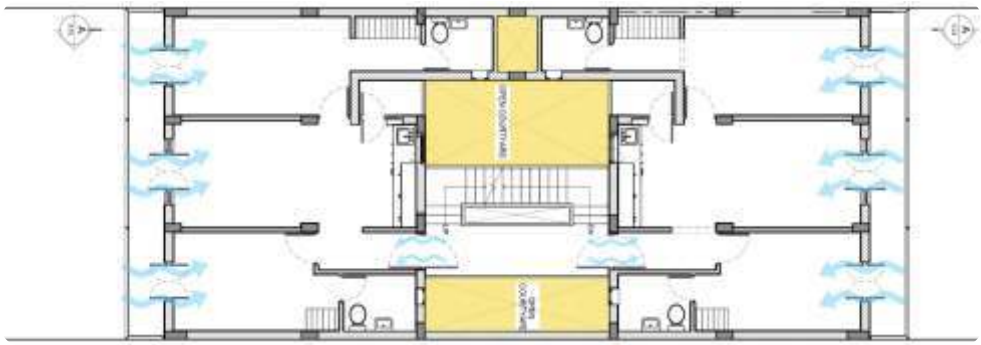


Figure 233: *Layout Plan*

Figure 234.1

Figure 234.2

Figure 234.3

Figure 234.4

Figure 234: *Interior Views of the Building*
Source: *Ashok B. Lall Architects*

Shading Devices

- The Architect has used a special shading element in the front and back facades of the building
- A metal sheet with perforations has been installed in the balconies
- This helps in cutting off the harsh sunlight that falls on the balconies and the rooms making them more usable during the hot summer days

Figure 235.1

Figure 235.2

Figure 235.3

Figure 235: *Metal Sheet with Perforation*
Source: *Ashok B. Lall Architects*

Doors & Windows

The architect has created an innovative and cost-effective fenestration design that functions as both a door and a window. The fenestration has been divided into 4 parts which can be opened and closed separately. This helped in eliminating the installation of windows in the building.

Figure 236: *Fenestration divided into 4 parts*

Figure 237: *Provision for evaporative coolers*

Walling Material

- The internal and external walls are made out of AAC blocks. The blocks are 200mm thick and have a U value of **0.75 watt/sqm.k**
- AAC blocks are lighter in weight when compared to red bricks, this helps in making a light weight structure

Figure 238.1

Figure 238.2

Figure 238: *AAC Blocks used as walling material*

White Roof

The roof of the building has been painted white. This white painted roof ensures that maximum amount of sunlight falling of the surface of the roof gets reflected back. The reflection of the heat keeps the interiors cooler.

Figure 239.1

Figure 239.2

Figure 239: *White paint on the roof*

Solar Rooftop

- Solar Panels have been installed on the roof of the building. The panels are installed in such a manner that they provide shade to the courtyard as well
- The solar panels currently installed have a total capacity of 8kW which can completely cater to the energy requirements of the building including energy consumption by Acs
- The capacity can be increased up to 30kW if required in the future

Figure 240.1

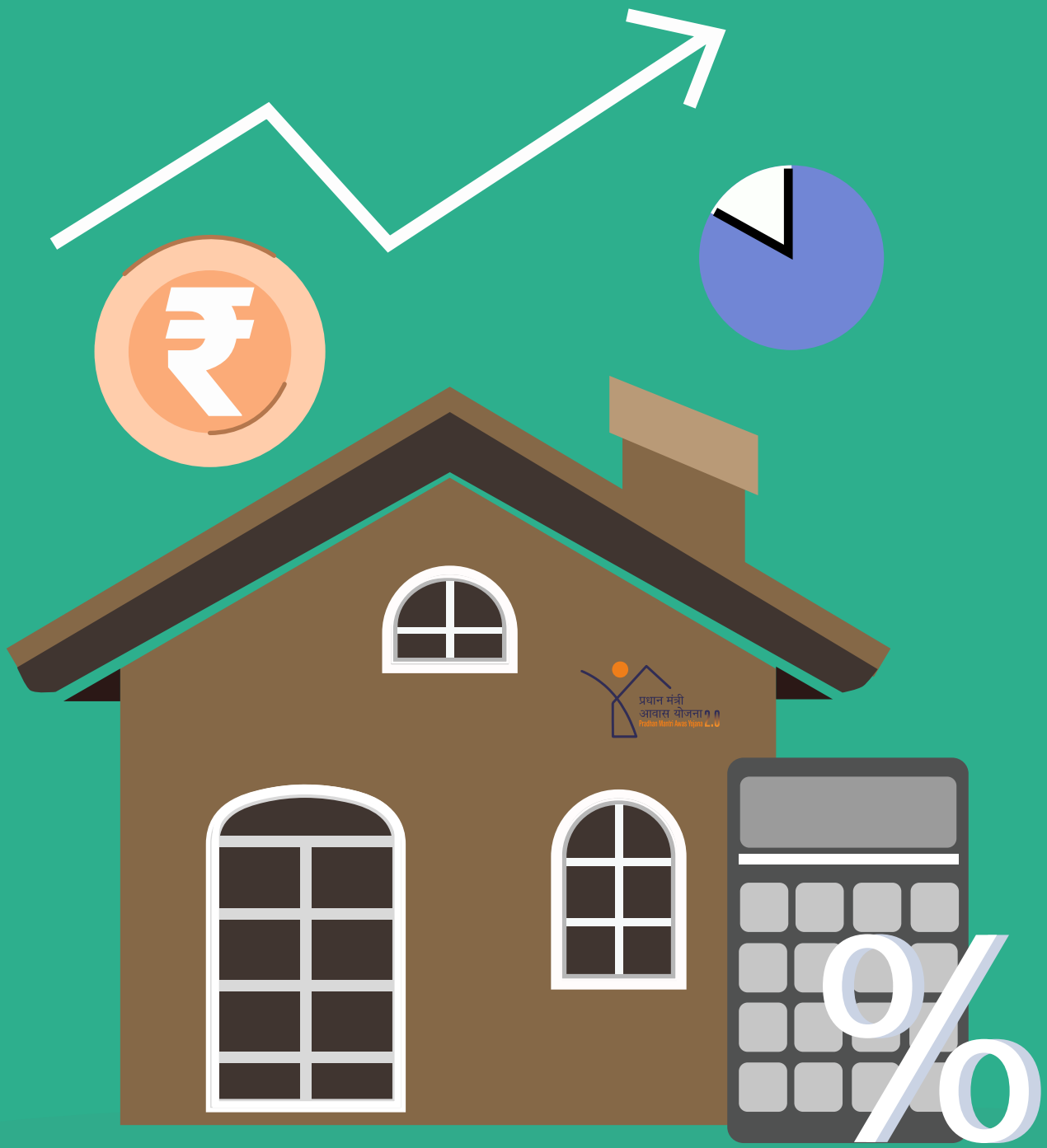
Figure 240.2

Figure 240: *Solar Panels on the roof*

Monitoring System

- A Schneider monitoring system has been installed in the building
- This system has the capacity to monitor the energy consumption and water consumption of the building
- The meter can monitor energy consumption for each of the electrical appliance which have been installed in the building
- The building will be monitored for 2 years using this metering system

Figure 241: *Metering System*


₹
प्रधान मंत्री
आवास योजना 2.0
%

MODULE V

FINANCE

This module provides information on accessing housing finance and navigating sustainable housing complexities, focusing on affordable housing programs like PMAY-U and PMAY-G.

TABLE OF CONTENTS

IN THIS MODULE...

...you will gain a comprehensive understanding of financing sustainable housing. You will explore various funding options, including government schemes like Pradhan Mantri Awas Yojana (PMAY-U & PMAY-G), state-level programs, lender incentives, and alternative financial models such as microfinance, cooperative housing finance, and peer-to-peer lending. Additionally, you will learn how to leverage organized finance for lower interest rates, transparent terms, and legal protections while understanding the drawbacks of unorganized finance.

This module also highlights the benefits of green housing finance, including special loan products for sustainable home construction and government incentives for self-built green homes. Furthermore, it provides insights into prudent savings strategies, budget management, and cost-effective construction techniques, such as using energy-efficient appliances, water conservation systems, and eco-friendly building materials. By the end, you will be equipped with the knowledge to navigate the financial landscape and make informed decisions toward affordable and sustainable homeownership.

NATIONAL AFFORDABLE HOUSING PROGRAM

Pradhan Mantri Awas Yojana - Urban (PMAY-U)

The Pradhan Mantri Awas Yojana – Urban (PMAY-U) is a flagship mission launched by the Government of India in 2015 under the Ministry of Housing and Urban Affairs (MoHUA). It is a transformative initiative aimed at addressing the housing needs of urban India, particularly focusing on the Economically Weaker Section (EWS), Low Income Group (LIG), and Middle Income Group (MIG), including those living in slum areas. The mission aspires to provide "Housing for All" by ensuring that every eligible urban household has access to a pucca house with basic amenities such as water, sanitation, and electricity.

PMAY-U adopts a demand-driven approach, whereby States and Union Territories (UTs) assess the housing needs of their populations, ensuring that the scheme is customized to address local requirements. This approach fosters inclusivity, enabling the scheme to cater to the diverse urban housing challenges across the country.

The implementation of PMAY-U is a collaborative effort involving multiple stakeholders. Key players include: State Level Nodal Agencies (SLNAs), Urban Local Bodies (ULBs), Central Nodal Agencies (CNAs), and Primary Lending Institutions (PLIs)

- Through these coordinated efforts, PMAY-U aims to transform the urban housing landscape in India, ensuring that affordable, safe, and sustainable housing becomes a reality for millions of urban families

118.64 Lakh	91.50 Lakh	₹1,68,141 Cr
Houses Sanctioned	Completed	Released
112.74 Lakh	**₹1,99,652 Cr**	**₹8.07 Lakh Cr**
Grounded	Committed	Investment

01 "In Situ" Slum Redevelopment	This vertical focuses on utilizing slum land as a resource by involving private sector participation. It offers additional incentives like extra FSI, TDR, or FAR to make projects financially viable and aims to redevelop slums into formal housing.

Source: *https://pmay-urban.gov.in/about*
Data as on 17th March, 2025

02 Affordable Housing through Credit Linked Subsidy Scheme (CLSS)	This vertical provides an interest subsidy for loans to EWS and LIG households to buy or construct new houses or improve existing ones. The EWS category covers families with annual incomes up to ₹3 lakh and house sizes up to 30 sq.m., while the LIG category is for families earning between ₹3,00,001 and ₹6,00,000. The scheme also extends subsidies to MIG categories for larger house sizes.
03 Affordable Housing in Partnership (AHP)	This involves housing projects built in partnership with private and public sectors, including parastatal agencies. Under this vertical, 35% of the houses constructed must be for the EWS category, with central assistance provided for each EWS unit.
04 Subsidy for Beneficiary-Led Individual House Construction or Enhancement (BLC)	This is designed for individuals in the EWS category who already own land but need financial assistance to either build or enhance their homes. States are tasked with preparing separate projects for these beneficiaries, ensuring the program is inclusive.

While all four verticals play a critical role, **the BLC vertical is particularly relevant for those aiming to construct their own houses,** followed closely by the CLSS. PMAY-U has now been followed by PMAY 2.0, which builds on the success of the first phase, continuing the mission to provide affordable housing to more urban households.

PMAY Vertical	Financial Assistance
Beneficiary-led Individual House Construction or Enhancement (BLC)	Under this vertical, Central Assistance of ₹1.5 lakh is provided to individual eligible families belonging to EWS categories.
Affordable Housing in Partnership (AHP)	Central Assistance of ₹1.5 lakh per EWS house is provided by Government of India in projects where at least 35% of the houses in the projects are for EWS category and a single project has at least 250 houses.
In-situ Slum Redevelopment (ISSR)	Slum redevelopment grant of ₹1 lakh per house is admissible for all houses built for eligible slum dwellers under the vertical of In-situ Slum Redevelopment using land as Resource with participation of private developer.
Credit Linked Subsidy Scheme (CLSS)	An interest subsidy of 6.5%, 4% and 3% on loan amount upto ₹6 lakh, ₹9 lakh and ₹12 lakh were admissible for the eligible beneficiaries belonging to Economically Weaker section (EWS)/Low Income Group (LIG), Middle Income Group (MIG)-I and Middle Income Group (MIG)-II respectively seeking housing loans from Banks, Housing Finance Companies and other such institutions. (CLSS for MIG was from 01.01.2017 to 31.03.2021)

Source: *https://pmay-urban.gov.in/about*

Pradhan Mantri Awas Yojana Urban (PMAY-U) 2.0

Pradhan Mantri Awas Yojna-Urban 2.0- "Housing for All" Mission for urban areas will be implemented for 5 years w.e.f. 01.09.2024 to provide Central Assistance to all eligible beneficiaries through State/UTs/PLIs to construct , purchase a house. The Scheme will be implemented through Four verticals:-

The Cities/Towns and areas falling under Notified Planning Areas, where PMAY-U is being implemented will continue to be covered under PMAY-U 2.0. Cities/ towns which were not part of PMAY-U may also be included in PMAY-U 2.0 with due approval of MoHUA.

01 **Beneficiary Led Construction (BLC)**	• EWS beneficiary to construct house on own land • Provision of land patta/ rights to the landless by States/UTS • Geo-tag the construction stages of the house by beneficiaries. • Release of instalment is linked to construction stage • Free of cost statutory approvals, if needed Up-gradation of Tenable Slums with housing and infrastructure
02 **Affordable Housing in Partnership (AHP)**	• EWS beneficiary to purchase/avail alloted houses in Apartment projects by public/private sector agencies/parastatal agencies • Redeemable Housing Vouchers for purchase of houses in white listed private sector projects • Various State Incentives to public/private projects • In-Situ Slum Redevelopment of tenable Slums or Slum Resettlement
03 **Affordable Rental Housing (ARH)**	• **Model-1:** Utilizing existing Government funded vacant houses by converting them into ARH under PPP mode or by public agencies. • **Model-2:** Construct, Operate and Maintain rental housing by Private/Public Entities for urban poor, working women, employees of Industries, Industrial Estates, Institutions and other eligible EWS/LIG families.
04 **Interest Subsidy Scheme (ISS)**	• Max. Loan value ₹25 lakh, Max. House Value ₹35 lakh • 5 Yearly instalments of Loan subsidy • Annual household income: -EWS - up to ₹3 lakh - LIG - up to ₹6 lakh - MIG - up to ₹9 lakh EWS/LIG/MIG-Loan Subsidy upto ₹1.80 lakh

Eligibility Criteria

Criteria for Family	• Income Limits for households - EWS- up to **₹3 Lakhs, LIG- ₹3- 6 Lakhs, MIG- ₹6-9 Lakhs.** • All family members shall have Aadhaar Card. • Beneficiary who has been allotted house under any scheme of CG/SG/UT in last 20 years shall not be eligible for any benefit under PMAY-U 2.0. • If there is female in family, house constructed/purchases under the scheme will be in the name of female head or jointly in the name of male head and female head. If there is no female, then house can be in the name of male head.

Criteria for Property	• Families of EWS/LIG/MIG living in urban areas shall not have pucca house anywhere in country
	• Scheme will support construction of house with minimum 30 sq mtr
	• There shall be mandatory lock-in period of 5 years from the date of:-
	  • Completion of house under BLC
	  • Possession of house under AHP and
	  • Disbursal of first instalment of HL under ISS
	• Beneficiary shall not be allowed to sell/ transfer the house during lock-in
	• Minimum beneficiary share of 25% of house cost/project cost is mandatory

Source: *https://pmay-urban.gov.in/about*
https://www.iiflhomeloans.com/pmay-urban

IIFL Home Finance Ltd & PMAY Urban

IIFL Home Finance Ltd. has played a pivotal role in supporting the government's Pradhan Mantri Awas Yojana (PMAY) initiative, facilitating **Credit Link Subsidy Scheme (CLSS)** to enable affordable housing for all. Through our efforts, we've made a significant impact by helping low- and middle-income families realize their dream of homeownership. Our commitment to providing accessible, sustainable housing finance aligns with the broader vision of PMAY, promoting financial inclusion and driving social change across the country

Beneficiary Led Construction (BLC) & Affordable Housing Projects (AHP)

29,485
Loans Disbursed to BLC & AHP Households

₹785.64 Cr
Disbursed to BLC & AHP Households

15,500
Affordable Housing in Partnership

Credit Linked Subsidy Scheme (CLSS)

73,000+
Loans to CLSS Beneficiaries

₹1,753 CR ($218.75 MN)
Credit linked Subsidy (under PMAY) Facilitated

(Data as on September 30th, FY 2024-25)

Pradhan Mantri Awas Yojna–Gramin (PMAY-G)

Pradhan Mantri Awas Yojana – Gramin (PMAY-G) (Gramin meaning Rural) was launched in 2016 and aims to provide a pucca house with basic amenities to all houseless households and households living in kutcha (temporary) and dilapidated houses in rural areas by 2024. The immediate objective is to cover 1.00 Crore households in rural areas, that are houseless or living in kutcha (temporary) / dilapidated house and enable construction of quality houses by the beneficiaries using local materials, designs, and trained masons.

Benefits	The Central Government is providing financial assistance to eligible citizens in rural regions to construct pucca houses. If the house is built on flat lands the new sanctioned amount is ₹1.2 lakh and if it is built in a hilly region, then the amount stands as ₹1.3 lakh. Along with financial assistance, the beneficiary is also offered 90 days of employment under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which effectively amounts to approximately R18000. Another ₹12000 will be used to construct toilets.
Eligibility	The eligible beneficiaries under PMAY-G will include all the houseless households and households living in one, or two-room houses with kutcha walls and kutcha roofs (as per SECC data, and subject to the exclusion process)

Rural Housing Interest Subsidy Scheme

The **Rural Housing Interest Subsidy Scheme (RHISS)** is a unique initiative designed to bridge the housing gap for rural households that fall outside the ambit of the **Pradhan Mantri Awas Yojana – Gramin (PMAY-G)**. This scheme specifically caters to rural families who live in **kutcha houses with more than two rooms** or **pucca houses with only one or two rooms**, and who require financial assistance to either construct a new pucca house or upgrade, modify, or expand their existing dwelling units.

While PMAY-G focuses on the most economically disadvantaged rural households, RHISS aims to address the housing needs of those who, although not eligible for PMAY-G, still require support to ensure safe and adequate housing. By targeting this **"missing middle"**, RHISS seeks to enhance rural housing conditions comprehensively.

Eligibility	The beneficiary residing in rural areas who have not availed the benefits of PMAY-G or who are in the permanent waitlist of PMAY-G. Here rural areas exclude statutory towns as defined in census 2011 and towns notified subsequently for coverage in PMAY-U. The beneficiary household also needs to be living in a kutcha house (with more than two rooms) or pucca houses with one or two rooms. Beneficiaries seeking housing loans from Banks, Housing Finance Companies (HFC) and other such notified institutions would be eligible.

Source: *https://pmay-urban.gov.in/about*

The beneficiaries would be eligible for interest subsidy with the following features:

Particulars	RHISS
Interest Subsidy (%p.a.)	3.00%
Maximum Housing Loan Tenure (in years)	30%
Maximum Eligible Housing Loan Amount for Interest Subsidy (INR)	2,00,000
Discount Rate for NPV calculation of interest subsidy (%)	9.00%

The interest subsidy will be at 3.0 % on the principal amount of the loan and shall be admissible for a maximum loan amount of first INR 2.00 Lakh, irrespective of the quantum of the housing loan. If the quantum of the housing loan is less than INR 2.00 Lakh, the subsidy will be calculated based on actual loan amount.

The Net Present Value (NPV) of the subsidy will be calculated based on a notional discount rate of 9.0% for the period of the loan and interest chargeable at the time of the loan is contracted, upfront subsidy shall be released to Primary Lending Institution (PLI).

The NPV of interest subsidy given to PLI will be deducted from principal loan amount of the beneficiary, who will then have to pay interest to PLI at an agreed documented rate, fixed or floating on effectively reduced housing loan for the whole duration of the loan. The agreed documented rate which the beneficiary will have to pay may vary as per PLI.

STATE HOUSING PROGRAMS

Apart from housing programs at the national level there are programs at the state level that converge with the national programs to provide land parcels and support for self-constructed housing.

ANDHRA PRADESH

- Pedalandariki Illu
- Jagananna Smart Town Scheme

KARNATAKA

- Karnataka Affordable Housing Policy 2016
- Atal Bihari Vajpayee Urban Housing Scheme
- Dr. B.R. Ambedkar Nivas Yojana – Urban
- Devraj Urs Housing Scheme – Urban
- Devraj Urs Housing Scheme – Rural
- Basava Housing Scheme

HARYANA

- Deen Dayal Jan Awas Yojna
- Haryana Housing Board Schemes

MADHYA PRADESH

- **Availability of Plots for the weaker sections of the society**
- Rule 10 of Madhya Pradesh Nagar Palika Rules-1998 mandates reservation of plots for urban poor in Plotted Development (colony) when area is over 0.4 hectare The reservation is 15% of the colony area for these plots
- Mukhyamantri Aawasiye Bhu-Adhikaar Yojana

SOURCES:

Andhra Pradesh

- *https://guntur.ap.gov.in/housing-for-all-poor/*
- *https://vakilsearch.com/blog/ysr-housing-scheme-2023/*

Haryana

- *https://tcpharyana.gov.in/Policy/DDJAY-APHP%202016.pdf https://www.99acres.com/articles/deen-dayal-jan-awas-yojana.html?source=app&visitor_id=4841351666719328599&abCookie=32*
- *http://hbh.gov.in/BookingForNewSchemes*

Karnataka

- *https://mohua.gov.in/upload/uploadfiles/files/Karnataka- Affordable-Housing-Policy-2016-06-17_FINAL.pdf*
- *https://www.magicbricks.com/blog/karnataka-housing-board/132257.html*

Madhya Pradesh

- *https://saara.mp.gov.in/saaraweb/BhuSwamiAdhikar/ruralplot.html*

FINANCING AFFORDABLE HOUSING

Role of Banks and Housing Finance Companies

Housing finance companies and banks in India play a pivotal role in facilitating access to housing finance for individuals and families across the country. These institutions offer a diverse range of financing schemes tailored to meet the specific needs of customers, often in collaboration with state and central government schemes. These schemes aim to make homeownership more accessible and affordable, particularly for lower-income households.

HFC typically offer home loans with competitive interest rates, flexible repayment options, and simplified documentation processes. Moreover, they often partner with government initiatives such as Housing for All (PMAY-U CLSS, PMAY-G, RHISS) to provide additional subsidies and benefits to eligible borrowers.

Banks, on the other hand, extend housing loans with similar features, leveraging their extensive branch networks and digital platforms to reach a wider customer base. Together, these institutions play a crucial role in fulfilling the aspirations of millions of Indians for homeownership, driving economic growth and social development in the process.

Benefits of Organized Finance Over Unorganized Finance

Organized financing, provided by formal institutions such as banks, non-banking financial companies (NBFCs), and housing finance organizations, offers a structured and regulated approach to meeting financial needs. In contrast, unorganized localized financing—typically provided by moneylenders or informal lenders—lacks standardization and transparency, often leading to exploitation and financial stress for borrowers. The benefits of organized financing go beyond just financial assistance; it promotes financial inclusion, stability, and empowerment, making it a sustainable and reliable choice for individuals and businesses alike. Below are the key advantages that make organized financing a superior alternative to unorganized localized financing.

1. Access to Formal Institutions

Borrowers can secure loans from regulated financial institutions, ensuring reliability and standardized practices.

2. Lower Interest Rates

Organized financing often provides loans at significantly lower interest rates compared to unorganized money lenders.

3. Transparent Terms and Conditions

Borrowers are informed of all terms upfront, eliminating hidden costs and ensuring clarity in agreements.

4. Legal Protection

Borrowers are protected by legal frameworks, ensuring fair practices and recourse in case of disputes.

5. Credit Score Building

Repayment history is tracked, helping borrowers build a credit score that can unlock future financial opportunities.

6. Flexible Repayment Options

Organized institutions often offer customized repayment schedules to suit the borrower's financial situation.

7. Sustainable and Responsible Practices

Loans are given after evaluating the borrower's ability to repay, promoting financial discipline.

8. Access to Government Schemes and Subsidies

Formal financing enables borrowers to benefit from government initiatives, including subsidies and support programs.

HOUSING FINANCE COMPANIES

The following HFC's offer low interest rates for self-constructed affordable housing:

IIFL Home Finance Ltd.

IIFL Home Finance Ltd. empowers first-time home buyers from Economically Weaker Sections (EWS) and Lower Income Groups (LIG) across 17 states in India, addressing their housing challenges and supporting their journey to homeownership. The company offers low-interest home loans and loans against property for house construction and purchase, catering to beneficiaries who have received government subsidies for housing. Its asset-light model, supported by co-lending arrangements, enables deeper market penetration across India. Beyond home financing, IIFL Home Finance Ltd. fosters a sustainable and inclusive future, one affordable home at a time.

- **Min Loan amount ₹2 lakhs**
- **Starting interest rate of 8.75% pa**
- **Flexible loan tenure up to 30 years**
- **Processing Fee up to 1.75% + GST**

Mandotory and Additional Required Documents

Salaried individuals

- Identity Proof
- Address Proof
- Income Proof
- Employment Proof
- Property Documents Required for Home Loans

Self-employed individuals

- Identity Proof
- Residence and Business Address Proofs
- Income Proof
- Business Registration Proof
- Business continuity proof
- Property documents necessary for housing loans

Source: *https://www.iiflhomeloans.com/*

TATA Capital

Tata Capital has started affordable housing policy to help people belonging to income group LIG or MIG to buy their own houses in India.

- Min loan amount ₹2 lakhs
- Starting interest rate of 10.10% pa
- Loan tenure up to 30 years.
- Processing Fee 0.50% + GST

Mandatory and Additional Required documents

All applicants

- Age Proof
- Photo Identity Proof
- Address Proof
- Employment Details
- Income Proof
- Loan Details
- Processing Fee Cheque

Self-employed individuals

- Business Proof

Salaried individuals

- Income Proof

Home First Finance

Home First provides technology driven, affordable housing finance to LIG and MIG segments who are buying or building their first homes. Home First Finance has a product for self-built housing called Home Construction Loan.

- Min loan amount ₹2 lakhs
- Starting interest rate of 8.0% pa
- Loan tenure up to 30 years
- Processing fee: Home Construction Loans for salaried: ₹11,990 to ₹23,990 + GST Home Construction Loans for self-employed: ₹13,990 to ₹24,990 + GST

Mandotory and Additional Required documents

All applicants

- Loan Application form
- A cheque for the processing fee
- Identity Proof
- Address Proof
- Photograph
- Bank statements

Salaried individuals

- Income Proof –
  Latest salary slips for 3 months. Latest Form 16 Latest Income Tax Return

Self-employed individuals

- Income Proof –
  Latest Income Tax Return P&L and balance sheet for 3 years Proof of business for last 3 years

Source:
https://www.tatacapital.com/
https://homefirstindia.com/?srsltid=AfmBOoptGGYI-lAh_y7onABWhMcYiT-8K2NICRrJ2Jnwnts2hDY2NfBV

Aavas Financiers Ltd.

Aavas Financiers Ltd offers small ticket size loans of 1 lakh to 7.5 lakhs for the affordable housing segment for various requirements. They have a product called home construction loan for the purpose of self-construction of a residential house property. The land may be freehold, a plot allotted by Development Authority, within Nagar Palika, or Gram Panchayat. They also offer special home loan products for women borrowers.

- **Min Loan amount ₹1 lakhs**
- **Starting interest rate of 8.5% pa**
- **Loan tenure up to 15 years can be exceeded to 30 years in some cases.**
- **Processing Fee 1% + GSTMin Loan amount ₹2 lakhs**

Mandatory and Additional Required documents

All applicants

- Signed Loan Application form with photograph.
- A cheque for the processing fee
- Identity Proof
- Address Proof
- Property Documents
- Income Proof

Salaried individuals

- Salary Slips/Bank Statement/Form 16
- Salary Certificate

Self-employed individuals

- IT Returns and/or Financial Statements of last 3 years
- Informal Income Documents

ALTERNATIVE METHODS OF HOUSING FINANCE

In today's rapidly evolving financial landscape, innovative initiatives are emerging to bridge the gap between underserved communities and essential financial services. This section explores the transformative work of Kaleidofin, Mahila Housing SEWA Trust, and Rang De, as they pioneer groundbreaking approaches to empower marginalized individuals, particularly women, with access to tailored financial solutions.

Source: *https://www.aavas.in/*

Kaleidofin

Kaleidofin is a financial technology platform that helps underbanked customers, particularly women, meet their real-life goals by providing tailored financial solutions. Goal based savings could be anything from expanding a business, constructing, or enhancing a house. Monthly investments of ₹500-5000 are collected and invested in a diverse portfolio of funds that earn better returns than savings deposit or gold.

Rang De

Rang De is an RBI regulated peer to peer lending platform (NBFC P2P) focused on providing timely and affordable credit to unbanked communities. The platform works through a network of individuals and social investors spread across the country who invest in the borrowers listed on the platform. Both lenders and borrowers have to register on the platform. The borrowers can ask for loans for a variety of purposes including micro-entrepreneurs, education, housing.

Mahila Housing Sewa Trust

Mahila Housing SEWA trust (MHT) is an autonomous organization promoted by the Self-Employed Women's Association (SEWA), established in 1994 with the overall objective of improving habitat conditions of poor women in the informal sector. It works in the area of Habitat Development, Climate Change Resilience and Promoting Participatory Planning.

One of the key activities of MHT is enabling access to microfinance for habitat development in low-income communities. This activity is critical to improving the living and working conditions of low-income families. More than 80% of workers in India work in the unorganized sector and lack formal documents of identification, address, and income. The lack of clear land titles and property deeds keeps them out of the formal financial system and prevents them from making significant improvements to housing.

Figure 242: *Mahila Housing Sewa Trust*

MHT provides micro loans to women to improve access to housing and infrastructure. These micro-lending are used for constructing toilets, improving water and wastewater disposal facilities, making home improvements, and making resilience investments. MHT has also worked to devise unique microloan products to finance property tax backlogs. This has cleared the way for families to secure legal water and sanitation services in slum areas of MP, Bihar, and Jharkhand.

Source: *https://Kaleidofin.com*
https://rangde.in/
https://csrbox.org/India_organization_-Gujarat-Mahila-Housing-Sewa-Trust_8396

GREEN SELF BUILT AFFORDABLE HOUSING

India's housing sector plays a crucial role in the country's economic growth, with the government introducing various initiatives to address housing demand. In addition to promoting affordability, sustainability has become a key focus, especially in self-built housing, which forms a significant portion of the total housing stock. Given India's commitment to achieving net-zero carbon emissions by 2070, incorporating sustainable practices in self-built homes is essential. While the environmental impact of individual homes may seem minimal, their collective effect can be substantial, contributing to carbon reduction and long-term resilience.

A crucial step in this transition is the adoption of **green ratings**, which provide a structured framework for evaluating and promoting sustainable building practices. These rating systems ensure that homes are designed with energy efficiency, water conservation, and environmentally responsible construction methods. They are particularly important for **economically weaker sections (EWS) and low-income groups (LIG)**, as they enable cost-effective solutions while improving living standards and minimizing environmental impact.

Recognizing the need for sustainability in self-built housing, various organizations have developed green certification frameworks like **JAN GRIHA, EDGE (Excellence in Design for Greater Efficiencies), IGBC NEST (National Eco-friendly Sustainable Township).**

By implementing these green rating systems, India is taking a significant step toward ensuring a **sustainable and affordable housing future**, where self-built homes contribute to national climate goals while enhancing the quality of life for millions.

Jan GRIHA

To address climate change and support sustainable standalone housing in India, the **GRIHA Council** launched **Jan Awas Nirman GRIHA (JAN GRIHA)**. This certification focuses on affordable housing for economically weaker sections (EWS) and low-income groups (LIG), encouraging the use of resource-efficient designs, low-energy materials, and sustainable construction practices. It empowers individuals to adopt green building principles while ensuring affordability, improved living conditions, and reduced environmental impact. JAN GRIHA plays a vital role in aligning affordable housing with India's vision of achieving carbon neutrality.

Certification Process

Each project shall have a maximum of two site visits: During construction Post completion

Step 1: Registration of Projects:

- Submit an online registration form available on the GRIHA website during the project's inception to integrate sustainable design from the start.
- Pay the registration fee (₹7,500 or $100) to initiate the process. Upon confirmation, the entity can begin submitting project documents.

Step 2: Training Program:

- The project team responsible for certification must attend a training program conducted by GRIHA to understand documentation and certification requirements. This training is offered for an additional fee.

Step 3: Site Visits:

- **During Construction:** GRIHA conducts a site visit to validate sustainable measures, ensure compliance, and document progress with photographs. Observations and recommendations are provided if needed.
- **Post-Completion:** A second site visit assesses compliance with final requirements and captures photographs of completed sustainable measures.

Step 4: Submission of Documents and Calculations:

- Post-completion, the project team submits all required documents and calculations for each criterion outlined in the JAN GRIHA manual.

Step 5: Evaluation and Award of Certification:

- GRIHA officials evaluate the submissions to verify compliance with certification standards. Upon successful evaluation, the project is awarded a certificate and a summary sheet highlighting its performance.

Cost

₹7,500 (excluding taxes) or $100. Certification is awarded only after fulfilling all manual requirements.

Source: *https://www.grihaindia.org/jan-griha*

EDGE Home Prescriptive Certification

How to Get Your Home Green Certified with IIFL HOME FINANCE!

EWS, LIG, MIG - All 5 parameters

1. **BRICKS**
   Use of non firedbricks eg. AAC block, Fly ash bricks, stone, or similar blocks

2. **REFLECTIVE PAINT ON ROOF**
   Use reflective paint, white paint or white tiles with SRI more than 70

3. **WINDOW OVERHANG**
   18 inch minimum overhang above window (except north slide)

4. **LOW FLOW SHOWERHEAD**
   Install Low flow showerheads with maximum capacity of 5 litres water per minute

5. **CEILING FAN**
   Use of 5 star rted ceiling fans or fans with less than 35 watts consumption

EWS, LIG, MIG - Either of the proposed parameters applicable

6. **DUAL FLUSH**
   Limited to 6/3 litres flush tank

OR

6. **RAINWATER HARVESTING**
   Use reflective paint, white paint or white tiles with SRI more than 70

OR

6. **LOW FLOW WATER TAP**
   Install aerators with a water flow rate of less than 4 litres per minute in all bathrooms and the kitchen of the house.

MIG - Either of the proposed parameters applicable

EWS LIG - not applicable.

7. **SOLAR PHOTOVOLTAIC PANEL**
   Installation with a minimum capacityof 300 Wp.

OR

7. **SOLAR WATER HEATER**
   Installation with a minimum of 100 litres of daily capacity

Cost

USD 50 (₹4,166) per home. Typically, the cost of certification is assumed by the Housing Finance Company.

Source: *https://edgebuildings.com/edge-home-prescriptive-certification/*

IGBC – NEST

The **IGBC NEST** rating system aims to promote sustainability in self-built and affordable housing projects across India. Designed for economically weaker sections (EWS) and low-income groups (LIG), it encourages the adoption of eco-friendly practices in planning, design, and construction. The framework provides clear, affordable guidelines to minimize environmental impact, conserve resources, and improve energy efficiency, fostering sustainable housing solutions nationwide.

Certification Process

Registration
Financial / Partner Institutions

↓

Guidance to Projects
IGBC AP Financial / Partner Institutions

↓

Documentation and submission to IGBC
Financial / Partner Institutions

↓

Post Construction

↓

Review
IGBC third party assessors

↓

Award of Certification
IGBC

Eligibility

IGBC – NEST caters to smaller low-cost residential buildings with **a built it-up area ≤ 150 m2**

Cost

The registration cum rating fee is ₹5,000/- (excluding taxes).

Benefits Of Green Affordable Housing!

Green concepts and techniques in eco-friendly self-developed tenements can help address the following:

- 20-30% reduction in Energy cost
- 30-50% reduction in Water requirement
- Improved health & wellbeing of occupants

We're committed to making sustainable housing more accessible. That's why **IIFL Home Finance Ltd. will cover the cost of green certification for you**, ensuring your home is both affordable and environmentally friendly.

Source: *https://igbc.in/igbcnest*

GOVERNMENT INCENTIVES FOR SELF-BUILT GREEN AFFORDABLE HOUSING

Greening PMAY-G

In the framework for implementation of PMAY-G (2022) there is a chapter: Greening PMAY-G, with the aim of "contributing towards a cleaner and healthier India.

They provide us parameters of aspired comfort and affordable housing, means of achieving green housing and guidelines on incentives/promotion of green housing.

Parameters of Aspired Comfortable & Affordable Housing

1. Comfort: Adequate space, light and vetilation, thermally comfortable in summer and winter.

2. Eco-friendly: Local specific orientation reducing need for artificial lighting and heating/ cooling, efficient water and waste disposal system and based on principles of recycle, reuse and renew.

3. Affordable: Cost effective and low maintenance intensive.

Common Major Materials Used in Housing & Their Impact

- **Brick** is CO_2 intensive, depletes top soil, fire wood, coal etc.
- **Cement** is CO_2 intensive, depletes lime stone, coal and other non- renewable resources.
- **Steel** is CO_2 intensive depletes oars and other non-renewable resources.

Depletion of **petrol /diesel** and cost increase for **transporting** cement and steel from long distances.

Means of Achieving Green Housing

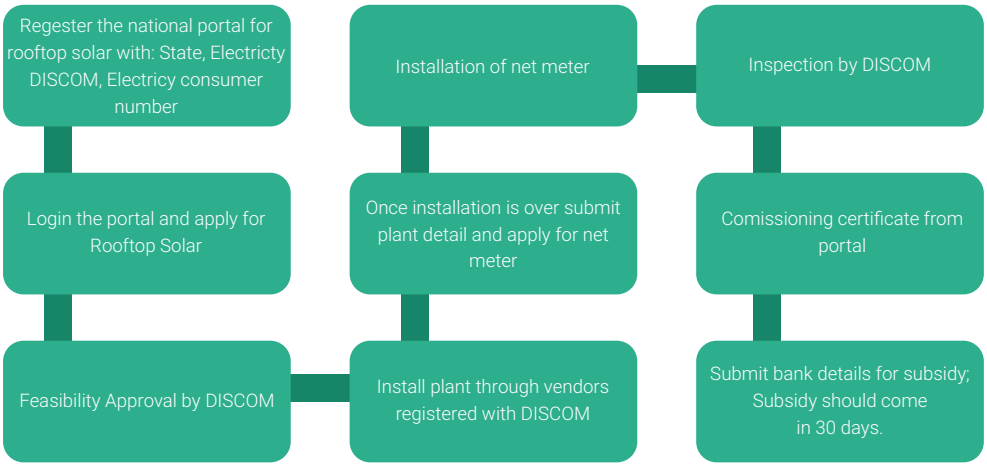
- Reduce consumption of cement, brick and steel by using alternative technologies.
- Use alternatives to brick, cement, steel etc.
- Use local materials- based technologies.
- Use renewable resources like bamboo etc.
- Integrate green materials and technologies with comfortable and affordable design

Initiatives for Energy

National Solar Mission

The National Solar Mission was inaugurated in January 2010 to create the policy conditions for the deployment of solar energy across the country. The mission has been revised twice and now boasts a target of 100 GW of solar PV by 2022. The National Solar Mission allows for subsidies and easy access to finance for roof top solar panels.

Process: The following is the process for availing subsidy for installing rooftop solar panels:



Source: *https://solarrooftop.gov.in/pdf/financial_options-20230726.pdf*

Unnat Jyoti Affordable LED for All (UJALA) Program

UJALA was launched in 2015 for promoting energy efficiency in India. Under UJALA scheme, LED bulbs, LED Tube lights and Energy efficient fans are being provided to domestic consumers for replacement of conventional and inefficient variant.

Over ₹36.86 crore LED bulbs, ₹72.18 lakh LED Tube lights and ₹23.59 lakh energy efficient fans distributed by Energy Efficiency Service Limited (EESL) across India. This has resulted in estimated energy savings of **₹48.42 billion** kWh per year with avoided peak demand of **9,789 MW**, GHG emission reduction of **₹39.30 million** t CO_2 per year and estimated annual monetary savings of **₹19,334 crore** in consumer electricity bills. Under Energy Efficient Fan program over 57,000 Brush Less Direct Current (BLDC) fans have been sold.

Figure 243: *Unnat Jyoti Affordable LED*

Eligibility	Every domestic household having a metered connection from their respective Electricity Distribution Company is eligible to get the LED bulbs under the UJALA Scheme. The consumer can purchase the LED on EMI payment (monthly/ bimonthly instalments in electricity bill) or on upfront payment by paying the full amount.
Benefits	UJALA appliances can be purchased at Rs 70 per LED bulb, Rs 220 per LED tube light and Rs 1110 per Fan.

Process

UJALA LED bulbs are being distributed through special counters (kiosks) set up at designated places in the city. These will not be available at retail stores. The consumer needs to carry the following documents to get the UJALA LED bulb:

- For **EMI** – Copy of latest electricity bill and copy of Government authorized ID proof
- For Upfront - Copy of Government authorized ID proof

Source: *https://eeslindia.org/en/ourujala/*

Initiatives for Cool Roof

A cool roof is designed to reflect more sunlight than a conventional roof, absorbing less solar energy which in turn lowers the temperature of the building. A traditional, dark material roof can reach temperatures of 65oC. Installing an appropriate cool roof technology can bring this down to under 40oC. Cool roof technology is relatively low cost passive strategy which has the following benefits:

The **India Cooling Action Plan (ICAP) 2019** recommends a cool roof policy as a strategy to provide thermal comfort for EWS and LIG housing.

Cool Roof Policy of Telangana 2023-28 sets a target of 300 sq. km. roof area for 2028.

Cool roofs are mentioned as a strategy to combat heatwaves in various heat action plans across the country like Ahmedabad Heat Action Plan 2018 and Tamil Nadu Heat Action Plan 2019.

Benefits	• Lowers the indoor temperature by, as much as, 2.1 to 4.3°C by not absorbing solar radiation • Reduces electricity bills due to lesser cooling requirement and AC loads, can save 20% in energy costs • If a high percentage of buildings adopt cool roofs it could reduce Urban Heat Island Effect by not radiating the trapped heat

FINANCING GREEN AFFORDABLE HOUSING

Financial institutions are crucial in advancing sustainable development, including green self-built affordable housing. Institutions like the Asian Development Bank (ADB), Kreditanstalt für Wiederaufbau (KfW), the Swiss Agency for Development and Cooperation (SDC) and the International Finance Corporation (IFC) promote this through investments and partnerships with Banks and HFCs. In India, banks such as Axis Bank, PNB Housing Finance Limited, and the State Bank of India have issued green bonds to fund environmentally responsible construction.

Local governments in India are also starting to issue green bonds, like the Ghaziabad Municipal Corporation's 2016 bond for a water treatment plant. Looking ahead, individual households in India can access green loans at affordable rates for eco-friendly home construction or retrofitting. This convergence of financial institutions, local governments, and affordable green loans presents a positive outlook for sustainable housing development in India.

Source: *http://ujala.gov.in/FAQ https://eeslindia.org/en/ourujala/*

Loan Products for Green Affordable Housing

IIFL Home Finance Ltd.

- IIFL Home Finance Ltd. has also looked at measures for promoting green home loans:

Benefits:

- Interest rate reduced by up to 1%
- Subsidy on home loan amount: 2.4%

Policy for Green Self Built Housing to be added here.

Bank of Maharashtra

Bank of Maharashtra has a product called Maha Super Green Housing Loan Scheme.

Eligibility: For purchase of house (Villas, Row House, Flat) in certified green housing projects rated by GRIHA, IGBC and LEEDs.

Benefits:

- No Processing Fee
- Concession rate of 0.10% in applicable ROI
- Quick Sanction to approved green projects.

Note:
There are also Financing Schemes available for Rooftop Solar from various banks and HFC.

Axis Bank

Axis Bank has partnered with Mahindra Lifespaces in Nov. 2023 to provide home loans for Green Homes.

Eligibility: for Mahindra Lifespaces customers

Benefits: Interest rate reduced by 0.25%

Aadhar Housing Finance

Aadhar Housing Finance has also looked at measures for promoting green home loans:

Benefits:

- Interest rate reduced by up to 0.5%
- Subsidy on home loan amount 2.4%

State Bank of India

State Bank of India plans to bundle home loans withs rooftop solar installations.

Source:
- *https://economictimes.indiatimes.com/industry/banking/finance/banking/green-funding-sbi-plans-to-bundle-home-loans-with-rooftop-solar-installations/articleshow/103695610.cms?from=mdr*
- *https://solarrooftop.gov.in/pdf/financial_options-20230726.pdf*

PRUDENT SAVINGS STRATEGIES THROUGH SUSTAINABILITY

Water Conservation

- **Reduced Water Bills:** Conserving water can directly translate into significant savings on your water bills, especially in cities where water is metered. By using water efficiently, you can lower your consumption and, consequently, your monthly expenses. Table 3 illustrates how key Indian cities have metered connections. Tier-2 or 3 cities that are not covered currently will also have metered connections eventually.

City	Quantity of water supplied (MLD)	Piped water (%)	Metered connections (%)
Mumbai	3350	76	81
Delhi	3546	81.3	55
Kolkata	599	92	1
Chennai	830	98	NA
Bengaluru	970	93	95.5
Hyderabad	1287	70	30
Ahmedabad	1210	90	0
Surat	980	95	NA
Jaipur	374	98.7	98
Vadodara	401.8	78	3
Nagpur	625	80	91.6
Lucknow	675	71	0
Coimbatore	137	88	30
Nashik	350	95	NA
Varanasi	276	77	NA
Indore	323	46	0
Thiruvananthapuram	268	78	100
Vishakhapatnam	291	54.9	2.16

Table16: *Percent Water Metered in Key Indian cities*

- **Long-term Cost Savings:** Module 3 discusses the various measures of conserving water like low flow showers and water taps, aerators in fixtures, dual flush etc. While the initial investment in water-efficient appliances or fixtures may seem daunting, the long-term savings they generate through reduced water usage can outweigh the upfront costs. Over time, the savings on water bills can accumulate substantially.

- **Avoiding Surcharges or Penalties:** Many cities in India have implemented water metering systems coupled with regulations to encourage conservation. By conserving water, you can avoid penalties or surcharges imposed on excessive water usage, thereby saving money that would otherwise be spent on fines.

- **Mitigating Future Price Increases:** As water scarcity becomes an increasingly pressing issue globally, the cost of water is likely to rise in the future. By conserving water now, you insulate yourself from potential price hikes, ensuring that your water bills remain manageable even as rates increase.

- **Reducing Indirect Costs:** Water conservation plays a crucial role in reducing the strain on water infrastructure systems, thereby mitigating the need for costly repairs, upgrades, or expansions. By using water efficiently, individuals and communities contribute to the longevity of existing infrastructure, ultimately saving taxpayers' money that would otherwise be spent on maintenance. Additionally, conserving water helps minimize the operational expenses associated with water extraction, treatment, and distribution, which can positively impact municipal budgets and relieve financial burdens on taxpayers.

- **Social Responsibility and Environmental Conservation Benefits:** Water conservation not only promotes financial savings but also fosters environmental sustainability and social responsibility. By using water efficiently, individuals and communities contribute to the preservation of vital ecosystems, safeguard biodiversity, and mitigate the impacts of droughts and water shortages, ensuring a healthier environment for current and future generations. Additionally, embracing water conservation practices fosters a culture of awareness and empowerment, promoting equitable access to this essential resource and building more resilient communities.

Waste Segregation

Government Mandate:

- In 2016, the Government of India introduced Solid Waste Management Rules, mandating waste segregation into bio-degradable, non-biodegradable, and domestic hazardous categories.

- The rules also emphasized the importance of handing over segregated waste to authorized waste pickers or collectors, as directed by local authorities.

- This policy is compulsory across India, some cities had already begun its implementation, turning waste management into an opportunity for economic growth and environmental improvement. At the household level, Solid Waste Segregation is important due to:

- **Health and Hygiene**
- **Resource Conservation and Cost Savings**
- **Environmental Responsibility**

Some Exemplary City Initiatives

1. Economic Benefits

- **Indore, Bhopal, Pune:** Cities embraced waste segregation, establishing waste-to-energy plants and compost production facilities.

  These initiatives created jobs and supplemental income, contributing to economic growth.

2. Quality of life:

Maharashtra: Panchgani and Vengurla implemented biogas plants, promoting cleaner energy sources.

Tamil Nadu: Coonoor transformed garbage pits into green parks, enhancing aesthetics and residents; quality of life.

3. Innovative Models:

Alappuzha, Kerala: Subsidized individual and community compost units promoted community participation in waste management, yielding valuable manure for gardens.

Figure 244: *Door to door collection*

Figure 245: *Biogas Power/Thermal*

Figure 246: *A biogas plant in Alappuzha*

Source: *www.smartcityindore.org/solid-waste/*
www.mahaurja.com/meda/en/off_grid_power/bio_energy/biogas_power
theprint.in/india/governance/india-learn-alappuzha-waste-management/19258/

Quiz Time!

1. Under the Pradhan Mantri Awas Yojana ------ Gramin (PMAY-G), how much financial assistance is provided for constructing a house in hilly regions?

   a ₹1.2 lakh
   b ₹1.3 lakh
   c ₹1.8 lakh
   d ₹1.5 lakh

2. How many days of employment are offered under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to beneficiaries of PMAY-G?

   a 60 days
   b 75 days
   c 90 days
   d 100 days

3. What is the starting interest rate offered by IIFL Home Finance Ltd. for house construction and purchase?

   a 7.50%
   b 8.75%
   c 9.50%
   d 10.10%

4. What is the maximum eligible housing loan amount for interest subsidy under RHISS?

   a ₹1,00,000
   b ₹2,00,000
   c ₹4,00,000
   d ₹3,00,000

GLOSSARY

Rate of Interest

The rate of interest, often simply referred to as interest rate, is the percentage of the principal loan amount charged by a lender to the borrower for the use of their funds. It is typically expressed on an annual basis and influences the cost of borrowing money. A higher interest rate implies higher borrowing costs for the borrower, while a lower interest rate results in lower borrowing costs.

Tenure

Tenure refers to the period for which a loan is granted, during which the borrower is required to repay the borrowed amount along with any applicable interest. It is commonly expressed in months or years. The tenure of a loan varies depending on the type of loan and the terms agreed upon between the lender and the borrower.

Eligibility Requirements

Eligibility requirements are the criteria that individuals or entities must meet to qualify for a particular loan or financial product. These requirements may include factors such as age, income level, credit score, employment status, and other financial obligations. Lenders use eligibility requirements to assess the creditworthiness and ability of potential borrowers to repay the loan.

Ownership Needs

Ownership needs refer to the specific requirements or preferences that individuals or entities have regarding property ownership. This may include factors such as the type of property (e.g., residential, commercial), location, size, amenities, budget, and long-term investment goals. Understanding ownership needs is essential for selecting the most suitable property and financing options.

Repayment Structure

Repayment structure outlines the terms and conditions for repaying a loan, including the frequency and number of payments, as well as any variations or flexibility in the repayment schedule. It defines how the borrowed funds, along with any accrued interest, will be repaid over the course of the loan tenure. Repayment structures can vary depending on the type of loan and the agreement between the lender and the borrower, ranging from fixed monthly installments to flexible repayment options.

CASE STUDY

SANJAYNAGAR REDEVELOPMENT COMMUNITY DESIGN AGENCY

Ahmednagar, Maharashtra

All images in the case studies are by IIFL Home Finance Ltd. unless otherwise credited.

SANJAYNAGAR REDEVELOPMENT COMMUNITY DESIGN AGENCY, AHMEDNAGAR, MUMBAI

Figure 247: *Sanjaynagar Redevelopment Community Design Agency*

Site Context

- The site is located on the outskirts of the **Ahmednagar** City which is 250kms from the State capital **Mumbai**
- Inhabitants from different part of the city were relocated to this 2 Acre Site by the government
- The Site is surrounded by agricultural plots
- The site was previously an agricultural field growing black cotton, which presents a significant challenge for construction

Figure 248: *Ahmednagar, Mumbai*

Figure 249: *Site Location & surroundings*

- A total of 8 no. of blocks have been planned for the project
- Out of these 8, 1 block has finished construction as of March 2022

Spatial Planning

Figure 250: *Floor Plan of the Block*

Figure 251: *Floor Plan*

- The building block contains a single core and houses 10-11 units
- The courtyard in between enables good daylight and ventilation
- The singly loaded corridors help in naturally lit and ventilation of the Units
- The structure is divided into 3 parts which are differentiated by Expansion Joints
- An open common space has been incorporated in the structure's built environment

Courtyards

- The Building Block has 4 Courtyards incorporated into it
- These courtyards provide light and ventilation to the internal units of the block
- They also help in enabling Stack effect in the structure
- The courtyard space at the ground level also act as a shared space for utility between the units

Figure 252.2

Figure 252.1

Figure 252.3: *Light & Ventilation through the Courtyard*
Figure 252: *Courtyard*

Roof

- Roof has been painted white to reflect off the harsh sun- light and keep the insides cool
- An additional layer of Brick Bats and waterproofing layer was also added on the top surface of the roof
- *'The layer of waterproofing and brick also acts as an thermal insulation layer for the roof' - Vandana Padmanabhan*
- The roof has also been designed to host a garden which will be used by the residents to grow vegetables

Figure 253: *Roof Garden*

Figure 254: *White Paint on the Roof*

Figure 255: *Metal shade on the roof*

Walling Material

- The Walls are made of **Fly Ash Bricks**
- The Fly ash bricks were procured from a local Fly Ash Manufacturer from Ahmednagar
- The composition of the blocks are as follows : **Fly Ash 38.73%, Dust 23.29%, Crushed sand 30.98%, Cement 7%**. The materials are mixed and compressed followed by curing. The Dust and the Crushed sand are waste products obtained from quarries. The difference is in particle size
- The Walls were finished with plaster and Paint
- Reinforcement rods were added in between the fly ash blocks to provide extra strength to the structure

Figure 256.1

Figure 256.2

Figure 256.3

Figure 256: *Flyash as Walling Material*

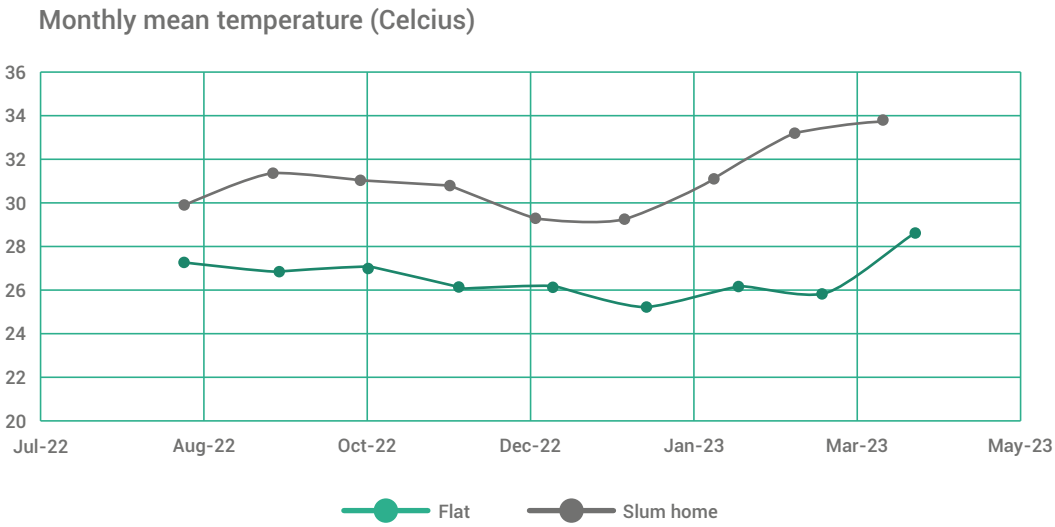


Figure 257: *Monthly Mean Temperature*

Padmanabhan, V. and Francis, A. (2024), Quantifying the thermal comfort improvement in a redevelopment project in compar- ison to semi-permanent homes in a densely populated slum; Construction Research Congress 2024: Sustainability and Resil- ience, American Society of Civil Engineers, Iowa.

Structure - Foundation

- The site is an agricultural land with **Black Cotton Soil**
- It is very difficult to build on Black cotton soil due to its low bearing capacity
- Due to this factor, **Pile Foundation** has been used in the structure of the building
- A pile foundation is basically a long cylinder of a strong material such as concrete that is pushed into the ground to act as a steady support for structures built on top of it
- Apart from this, a **Hollow Plinth** has been used in the struc ture
- The space between the plinth and the ground level has not been filled in this building. This ensures that the soil pressure does not come on to the building

Figure 258: *Hollow Plinth*

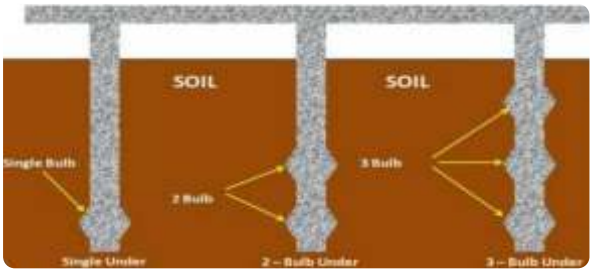


Figure 259: *Pile Foundation*

Figure 260: *Black Cotton Soil*

Plank & Joist Construction

- Plank and Joist Construction are a type of building structure commonly used in floors and roofs, where horizontal beams (called joists) are spaced apart and support long, flat boards (called planks) that form the surface of the floor or roof
- Mild steel joists combined with Kharapa stones have been used in the construction

Figure 261.1

Figure 261.2

Figure 261: *Plank & Joist construction*

Bamboo Shading Panels

- Shading Panels have been used in the Corridors
- These Panels are made out of Bamboo attached to an MS Frame
- These panels provide an interesting play of light and shadows in the corridors

Figure 262.1

Figure 262.2

Figure 262: *Bamboo attached to a MS Frame*

Figure 263: *Light & Shadow through Bamboo shading panels*

Design Innovation

- Efforts were also made to house bigger families under the same roof
- This was done by making modifications to the units according to the needs of the residents
- For example, vertical connections were made to

Figure 264: *Vertical Staircase Design for Bigger Families*

house a joint family

- The Eldest in the family were given the ground floor while the upper floors were given to their 2 sons. An internal steel stair- case made sure that the apartments were interconnected with each other
- Horizontal connections in form of steel bridges were also made to connect units adjacent to each other
- These were housed in courtyards

Figure 265: *Bridges to connect adjacent units*

Participatory Planning

- Household surveys were conducted by teams from Snehalaya Foundation with the residents of Sanjanyangar Slum, which recorded the information on various social parameters as per the format prescribed in PMAY guidelines, as well as photographic documentation of beneficiaries
- Residents were asked to choose their respective neighbors themselves using colored models, site plans etc

Figure 266.2

Figure 266: *Resident's Participation*

Figure 266.1

Figure 267: *Active involvement of the residents*

Answer Key

Module I: Building Typologies

Ques. 1. What should be the preferred building orientation for your house given that there is room for flexibility?

Ans. (a) North-South

Ques. 2. According to the statement, "A good structural engineer will design the most economical foundation and structure. A good design will not use more than ____ kg of reinforcement steel per sqm. of gross built-up area." Fill in the blank?

Ans. (a) 28 kg

Module II: Materials, Construction Techniques and Elements

Ques. 1. For Buildings up to how many floors is constructing a load-bearing structure considered a good option?

Ans. (c) Ground+3

Ques. 2. Which of the following is not an example of a shading device?

Ans. (d) Column

Ques. 3. Which of the following is an Eco Friendly for doors and windows?

Ans. (b) Timber

Module III: Services and Equipment

Ques. 1. Desert cooler works best in which of the following climatic conditions?

Ans. (a) Hot and Dry

Ques. 2. Which of the following ratings for appliances is the most energy efficient?

Ans. (d) 5 Star

Module IV: Maintenance Manual

Ques. 1. **What type of railing design is recommended for better safety and easier cleaning?**

Ans. (b) Vertical railing design

Ques. 2. **How often should white paint on a roof be re-applied to maintain its reflectivity?**

Ans. (b) Every 5 years

Ques. 3. **Which material is recommended for bathroom flooring to ensure it is water-proof and easy to clean?**

Ans. (c) Ceramic/Vitrified tiles

Module V: Finance

Ques. 1. **Under the Pradhan Mantri Awas Yojana – Gramin (PMAY-G), how much financial assistance is provided for constructing a house in hilly regions?**

Ans. (c) ₹1.3 Lakh

Ques. 2. **How many days of employment are offered under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to beneficiaries of PMAY-G?**

Ans. (d) 90 days

Ques. 3. **What is the starting interest rate offered by IIFL Home Finance Ltd. for house construction and purchase?**

Ans. (b) 8.75%

Ques. 4. **What is the maximum eligible housing loan amount for interest subsidy under RHISS?**

Ans. (b) ₹2,00,000

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LIST OF
ABBREVIATIONS (1)

- **CO2:** Carbon Dioxide
- **ADB:** Asian Development Bank
- **EWS:** Economically Weaker Section
- **LIG:** Low-Income Group
- **MSME:** Micro, Small & Medium Enterprises
- **BN:** Billion
- **CR:** Crore
- **USD:** United States Dollar
- **B2B:** Business-to-Business
- **B2C:** Business-to-Consumer
- **NBFC:** Non-Banking Financial companies
- **NPA:** Non- Performing assets
- **FY:** Financial Year
- **GVP:** Green Value Partner
- **TA:** Technical Assistance
- **UCCRTF:** Urban Climate Change Resilience Trust Fund
- **RWA:** Resident Welfare Association
- **DIY:** Do It Yourself
- **CARBSE:** Centre for Advanced Research in Building Science & Energy
- **CRDF:** Centre for Research, Development, and Future
- **Ar.:** Architect
- **IGBC:** Indian Green Building Council
- **GRIHA:** Green Rating for Integrated Habitat Assessment
- **EDGE:** Excellence in Design for Greater Efficiencies
- **COP:** Conference of the Parties
- **IFC:** International Finance Corporation
- **HFC:** Housing Finance Company
- **PMAY:** Pradhan Mantri Awas Yojana
- **SDG:** Sustainable Development Goals
- **ABLA:** Ashok B Lall
- **PCM:** Phase Change Materials
- **EW:** East West
- **Sqm:** Square Meter
- **RK:** Room Kitchen
- **BHK:** Bedroom, Hall, Kitchen
- **RWH :** Rainwater Harvesting
- **IMAC:** India Model for Adaptive Comfort
- **SI:** International System of Units
- **W/m2:** Watts per Square Meter
- **m2K/W:** Square Meter Kelvin per Watt
- **IP:** Ingress Protection
- **°F/ Btu:** Degrees Fahrenheit per British Thermal Unit
- **SHGC:** Solar Heat Gain Coefficient
- **VLT:** Visible Light Transmission
- **Kg:** Kilogram
- **CSEB:** Compressed Stabilized Earth Blocks
- **LPD:** Lighting Power Density
- **Kwh:** Kilowatt-hour
- **DW:** Double Wall
- **AAC:** Autoclaved Aerated concrete
- **RCC:** Reinforced Cement Concrete
- **PUF:** Polyurethane Foam

LIST OF
ABBREVIATIONS (2)

- **FFL:** Finished Floor Level
- **LVL:** Laminated veneer lumber
- **UPVC:** Unplasticized Polyvinyl Chloride
- **FSC:** Forest Stewardship Council
- **PEFC:** Programme for the Endorsement of Forest Certification
- **SFI:** Sustainable Forestry Initiative
- **GL:** Glued Laminated
- **GRC:** Glass Reinforced Concrete
- **WPC:** Wood Plastic Composite
- **MS:** Mild Steel
- **LED:** Light Emitting Diode
- **BEE:** Bureau of Energy Efficiency
- **BLDC:** Brushless Direct Current
- **PV:** Photovoltaic
- **AC:** Air Conditioner
- **LCD:** Liquid Crystal Display
- **EV:** Electric Vehicle
- **LT:** Low Tension
- **WC:** Water Closet
- **AMC:** Annual Maintenance Contract
- **LIG:** Lower Income Group
- **PMAY:** Pradhan Mantri Awas Yojana
- **MoHUA:** Ministry of Housing and Urban Affairs
- **MIG:** Middle Income Group
- **UT:** Union Territories
- **SLNA:** State Level Nodal Agencies
- **ULB:** Urban Local Bodies
- **CNA:** Central Nodal Agencies
- **PLI:** Primary Lending Institutions
- **CLSS:** Credit Linked Subsidy Scheme
- **AHP:** Affordable Housing in Partnership
- **BLC:** Beneficiary Led Individual House Construction
- **EWS:** Economical Weaker Sections
- **ISSR:** In-situ Slum Redevelopment
- **MGNREGA:** Mahatma Gandhi National Rural Employment Guarantee Act
- **SECC:** Socio-Economic and Caste Census
- **RHISS:** Rural Housing Interest Subsidy Scheme
- **HFC:** Housing Finance Companies
- **PLI:** Primary Lending Institution
- NPV: Net Present Value
- **NBFC:** Non-banking financial companies
- **SEWA:** Self Employed Women's Association
- **MHT:** Mahila Housing SEWA trust
- **UJALA:** Unnat Jyoti Affordable LED for All
- **EESL:** Energy Efficiency Service Limited
- **GHG:** Greenhouse Gas
- **BLDC:** Brush Less Direct Current
- **ICAP:** India Cooling Action Plan
- **KfW:** Kreditanstalt für Wiederaufbau
- **SDC:** Swiss Agency for Development and Cooperation
- **IFC:** International Finance Corporation
- **MLD:** Million Litres per Day

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