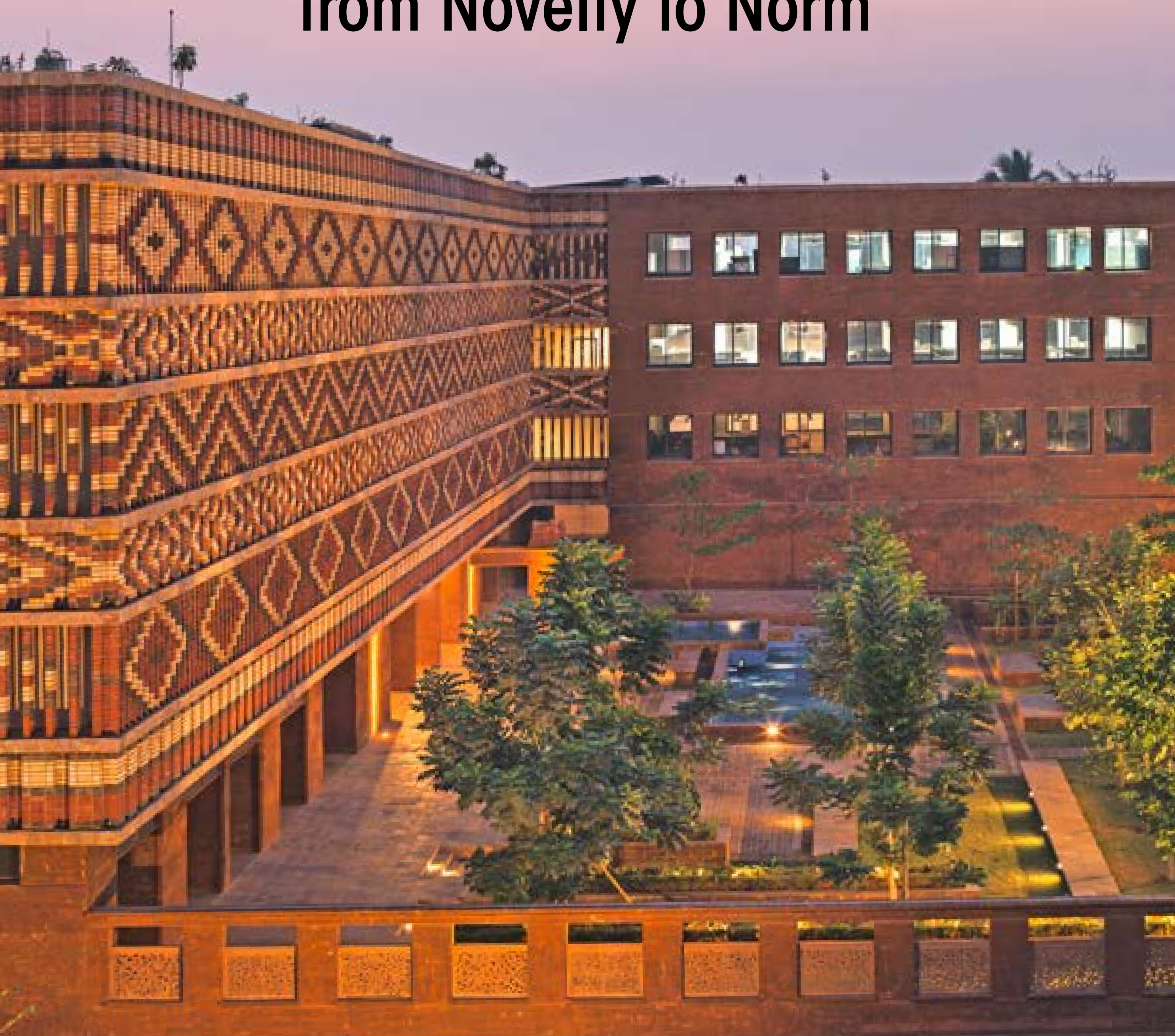
BEYOND CONCRETE

Low-carbon Solutions from Novelty to Norm



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Low-carbon Solutions from Novelty to Norm

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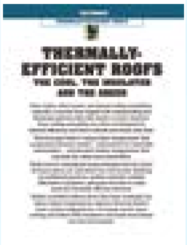

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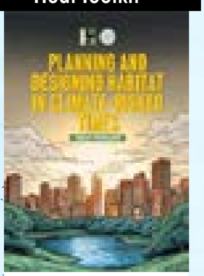


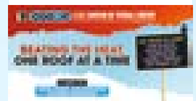
Extreme heat is no longer just an environmental challenge. It is a public health and livelihood crisis. With worsening climate conditions, 30 per cent of the global population already faces dangerously high temperatures for at least 20 days a year, and this is only set to grow. Over the past two decades, India has seen a 62 per cent increase in heatwave-related deaths due to a 138 per cent rise in the frequency of heatwaves.

Heat is not sparing any corner of India. Cities have it worse. From plains to hills to coastal areas, it is taking different shapes and sizes and pushing all beyond capacity to adapt. The most vulnerable are the worst affected. Amidst this, cities not only need emergency response for such groups but also strategies that work.

The Centre for Science and Environment's (CSE) campaign Cool It! focuses on practical solutions to address the challenge of rising heat. With the theme 'How to beat the heat affordably: In homes, buildings and cities', this campaign seeks to make thermal comfort a priority and a basic need and provide actionable strategies for adaptation.

To know more about the campaign, scan the QR code

POLLS AND QUIZ



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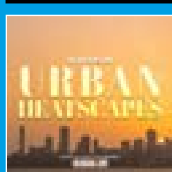

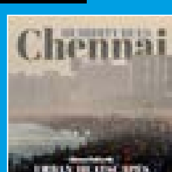

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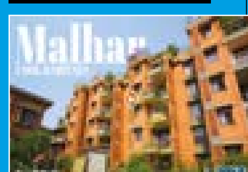
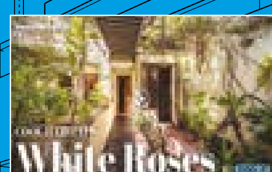




1 INTRODUCTION

- Material choices will play a crucial role in determining the carbon intensity of future building stock, influencing both embodied carbon and operational energy use.
- Concrete is the world's second-most widely used material and among the largest industrial contributors to global warming due to the carbon-intensive nature of cement.
- The mass housing sector is increasingly dominated by monolithic concrete technologies such as precast and poured concrete.
- Speed-driven construction prioritizes quick returns over the long-term comfort and efficiency of buildings.
- CSE's analysis shows that concrete walls allow nearly double the heat ingress compared to many non-conventional technologies.

The building and construction sector is a major global contributor to carbon emissions, both due to the embodied carbon of construction materials and the sector's substantial energy use. In 2023, emissions from the sector, including those from embodied carbon, accounted for 34 per cent of global energy-related CO_2 emissions, while its energy consumption made up roughly 34 per cent of global energy demand.[1]

India reflects this global trend. The Bureau of Energy Efficiency (BEE) estimates that the building sector consumes over 30 per cent of the country's total energy.[2] Furthermore, it is estimated that the energy use from the buildings sector in India is increasing by 8 per cent annually.[3] Residential buildings in India account for nearly 75 per cent of the total electricity consumed within the building sector, making it the biggest contributor. The rise in electricity consumption in homes has been sharp, growing from 55 terawatt hours (TWh) in 1996–97 to about 260 TWh in 2016–17, a nearly five-fold increase. Projections show it could rise to 630–940 TWh by 2032.[4]

This growth in energy consumption is tied closely to the rapid expansion of India's building stock. According to forecasts by the International Energy Agency (IEA) and BEE, between 40–50 per cent[5, 6] of India's future building stock is yet to be built. This expansion will lead to a significant rise in both operational energy demand as well as demand for construction materials and energy associated with their production.

Building-material choices will affect India's goals and commitments

India's long-term low-carbon development strategy recognizes that the national power demand can be reduced significantly by 2030, by improving the energy efficiency of buildings design, construction, and operations. It further emphasizes the role of choosing sustainable construction materials and methods of construction to achieve this. Further, India has also set a target of achieving 'Thermal comfort for all' as mentioned in India Cooling action plan. Appropriate material choices will be a key factor to achieve these.

Addressing emissions from the building sector is also essential for India to achieve its climate targets, including reducing the emissions intensity of its GDP by 45 per cent by 2030 and meeting its ambitious goal of net-zero carbon emissions by 2070. The Indian construction sector emits around 500 million metric tonnes of CO_2 annually from embodied carbon alone—a figure likely to double with accelerating urbanization.[7] Construction materials such as cement and steel will be major contributors to this. Studies project that India's demand for cement and steel could soar to 1,360 million tonnes (MT) and 755 MT by 2050, up from 328 MT and 99 MT in 2019, respectively[8] if conventional practices continue. This underscores the urgent need to reassess how these materials are used to mitigate future environmental and resource pressures.

Hence, material choices will play a crucial role in determining the carbon intensity of future building stock, impacting both embodied carbon from construction materials and the operational energy consumption of buildings. Without significant improvements in material efficiency and energy performance, these targets will be difficult to meet, highlighting the urgency of adopting low-carbon alternatives and sustainable construction practices.

What makes concrete among the biggest culprits?

Concrete is the second-most widely used material in the world after water, and its production is only expected to grow from 14 billion cubic metres today to around 20 billion cubic metres by the middle of this century[9] as cities expand and infrastructure needs increase. Concrete has become the backbone of our urban landscape, but it comes with a hidden cost. Every beam, pillar and slab consumes vast amounts of sand, gravel and water—precious resources that nature takes centuries to create but are being used up much quicker than they can be replenished.

What's more concerning is that producing cement, the key ingredient in concrete, is extremely carbon-intensive. Massive kilns burn fossil fuels and release large amounts of greenhouse gases, making concrete one of the largest industrial contributors to global warming. Production of 1 kg of cement releases almost an equal amount of up to 0.8 kg of carbon dioxide.[10] Globally, a person ends up using more than 500 kg of cement on average in a year.[11] If the cement industry were a country, it would rank as the world's third- or fourth-largest emitter of carbon dioxide.[12] In 2022 alone, global cement production released about 1.6 billion tonnes of CO_2—nearly 8 per cent of the world's total emissions.[13]

Despite using so many resources and being a leading cause of emissions, concrete buildings often don't give us much comfort in return. In hot weather, they trap heat and feel like ovens, while in winter they turn cold and uncomfortable, making us spend even more energy on air conditioning and heaters. Unlike natural materials that can breathe or keep temperatures steady, concrete does not adjust well to the weather but instead works against it.

Steel and cement are among the most carbon-intensive building materials, together accounting for approximately 18 per cent of global CO_2 emissions related to the building sector.[1] In addition to their carbon footprint, the construction industry heavily depends on raw materials like sand and gravel, which are essential components of concrete. These materials alone make up an estimated 69–85 per cent of all annual mineral extraction activities worldwide.[2] The growing demand for sand and gravel is a clear indicator of the industry's rapid expansion, highlighted by a six-fold increase in global sand trade over the last two decades.[3] This surge not only places pressure on natural ecosystems but also raises concerns about the long-term sustainability of resource extraction practices in construction.

Sources:
1. United Nations Environment Programme, & Global Alliance for Buildings and Construction, 2025. *Not just another brick in the wall: The solutions exist—Scaling them will build on progress and cut emissions fast. Global Status Report for Buildings and Construction 2024/2025.* https://wedocs.unep.org/20.500.11822/47214
2. The Economist 2017. Why There Is a Shortage of Sand, The Economist Explains. Available at https://www.economist.com/the-economist? -explains/2017/04/24/why-there-is-a-shortage-of-sand, last accessed in July 2025.
3. Ishan Kukreti 2018. India can rely on sand imports till the time it is viable, Environment, Down to Earth. Available at https://www.downtoearth.org.in/environment/india-can-rely-on-sand-imports-till-the-time-it-is-via ble-60892, last accessed in July 2025.

Evolution of construction technologies

Construction technologies over millennia were developed in response to the local context, evolving from the available regional resource base. Various materials were adapted, modified and tested over time, resulting in diverse, non-homogeneous systems tailored to specific geo-climatic conditions, with each component serving a distinct functional role.

As an example, a cob wall construction may utilize materials such as soil (which consists of sand, silt, gravel and clay), thatch, lime and water. Clay acts as a binding material while sand adds the strength component. Thatch plays a crucial double role—dried thatch generally obtained from either local vegetation or agricultural waste adds tensile strength to the wall making it less brittle and hence making it less prone to cracking. In addition, it also provides the walling with better insulation. The cob wall made layer by layer is finally coated with a plaster that is made from finer clay and sometimes even lime; this binds the wall and protects it. An additional layer of linseed oil could also be added to make the structure more water resistant where necessary. Hence, all these components of the walling assembly are essential for the technology to function well in the context where it is located. The technology's suitability to local conditions and its use of readily available local resources resulted in low embodied energy while also ensuring thermal comfort for occupants.

The next stage of evolution in this journey of walling brought about use of homogenous materials such as burnt red brick, fly-ash brick, monolithic concrete etc. These materials, however, often lack the multi-dimensional usage that different components of non-homogenous materials provided. As an example, concrete performs well in terms of providing structural stability but poorly in ensuring occupant thermal comfort and energy efficiency. This switch to homogenous materials has taken place very quickly and without much thought given of its consequence on the occupant.

Time factor currently dictates material choice and construction technology

The current construction landscape is dominated by fast construction technologies. In the commercial sector, glass has emerged as the preferred material for façades, while the mass housing sector is increasingly dominated by monolithic concrete technologies such as precast and poured concrete.

Till about a decade ago, the more widespread practice in mass housing sector was to use concrete in structural elements such as columns, foundations and beams etc. while non-load bearing walls utilized more energy-efficient materials that were better at providing thermal comfort. The current dominance of concrete as a walling material in the form of concrete blocks, precast concrete walls or MIVAN construction is a worrying trend. The driving force behind this transition is primarily the need to save time. Traditional brick-by-brick construction is more time-consuming compared to monolithic concrete alternatives, making speed a critical factor in decision-making.

Although monolithic concrete construction is more expensive than many conventional techniques, its ability to expedite project completion makes it a favoured choice in the industry. Faster construction not only reduces labour costs

In MIVAN construction, concrete is poured in formwork and the walls are load-bearing. This eliminates the need for columns and beams being cast separately and makes the process of construction faster.

Source: CSE

but also accelerates the timeline for generating returns on investment. Since a building can only start generating revenue once the project is complete, developers are inclined to prioritize technologies that shorten the construction period, often aiming to finish projects within three years or less. As a result, the market has adapted to prioritize speed and efficiency over cost-effectiveness, driving widespread adoption of these time-saving technologies. This approach however is short-sighted and ignores the effect it will have on the occupant post occupancy and during the lifetime of the building.

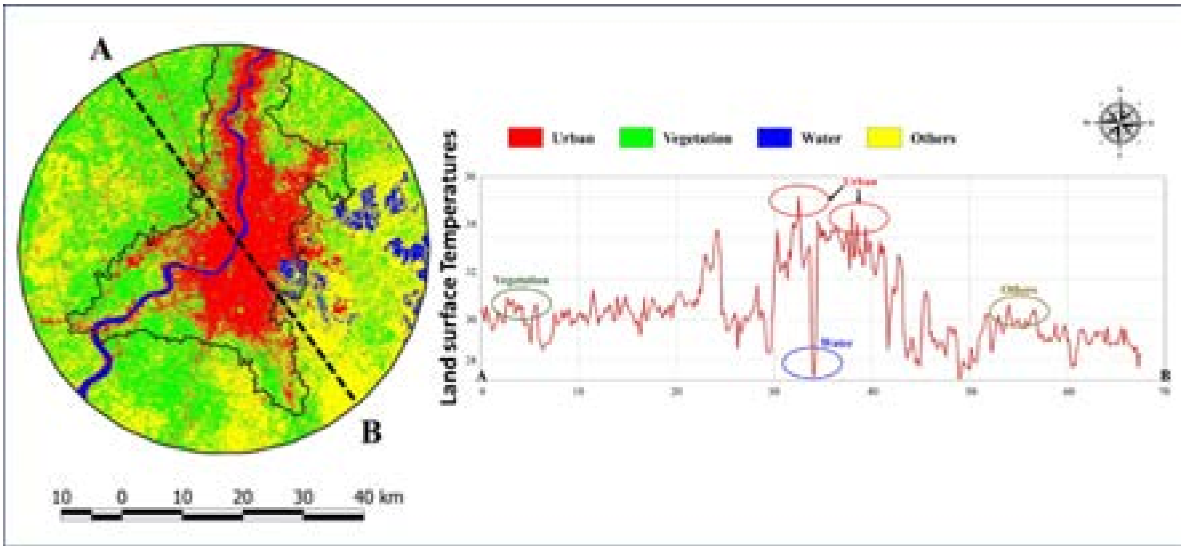
Materials play a pivotal role in thermal comfort

In any building, thermal comfort for occupants is influenced by a combination of factors. The Centre for Science and Environment's (CSE's) 2020 report *Optimizing the Third Skin* and 2021 report *Guidelines for Affordable Housing in Telangana* showed that both design strategies and material choices play critical roles in achieving this. Thoughtful design elements such as the building's orientation, placement of windows and open spaces, use of sun-shading devices, and layout of rooms can significantly reduce heat gain and improve natural ventilation. However, in many urban settings, site constraints such as irregular plot shapes, presence of closely spaced neighbouring buildings or ongoing adjacent construction can limit the scope of design interventions. In India, most buildings are still naturally ventilated; in such contexts, the choice of materials becomes even more crucial as they become the primary defence against heat.

Materials with appropriate thermal properties can help regulate indoor temperatures by reducing heat absorption, improving insulation, and enhancing overall energy efficiency. When design possibilities are restricted, it is often the materials that ultimately determine the thermal performance of the building. Exterior construction materials of a building form the first line of defence against harsh climatic conditions. They take the brunt of harsh heat in summers to ensure that less amount of heat gets transferred inside the building and onto the occupant or stop the heat from escaping to the outdoors in winters.

To understand the effect of choosing the appropriate external material on thermal comfort, CSE conducted an analysis for a housing project in Telangana[14] and found that material choices have a significant impact on the thermal comfort of a dwelling. The study simulated the impact of multiple walling materials on the thermal comfort of its occupants. The base case was taken as concrete blocks of 150 mm thickness.

Figure 1: Surface temperatures are much higher in heavily concretized areas than in areas with more vegetation and waterbodies: Study in Kolkata



Source: Exploring temperature indices by deriving relationship between land surface temperature and urban landscape. Remote Sensing Applications: Society and Environment, 18, 100299.

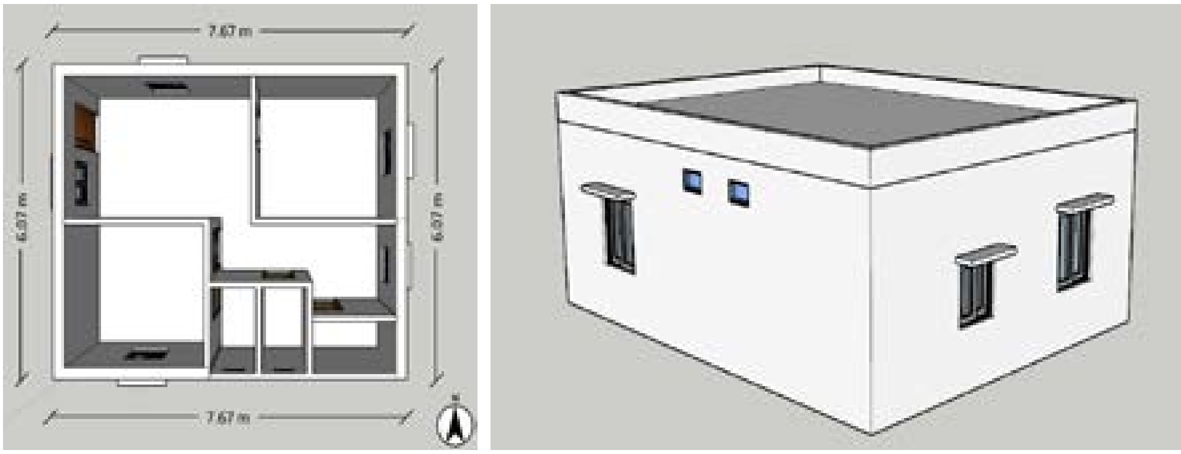
The study found that by choosing an appropriate walling assembly, the occupant could gain around 200–250 additional thermally comfortable hours annually. Once the appropriate walling assembly choice was combined with appropriate design strategies, the thermally comfortable hours gain over the base case scenario was found to reach up to 320–370 thermally comfortable hours.[15]

Moreover, as urbanization intensifies and more surfaces are covered with concrete and similar materials, cities experience a rise in temperatures, a phenomenon known as the Urban Heat Island effect. This occurs because materials like concrete have high thermal mass, allowing them to absorb large amounts of heat during the day and release it slowly at night. Unlike natural surfaces such as soil or vegetation, which stay cooler, these built surfaces retain significantly more heat. As a result, urban areas with widespread concretization are often noticeably warmer than surrounding rural regions.

How non-conventional technologies fare vis-à-vis concrete: Heat ingress analysis using Residential Envelope Transmittance Value as indicator

The thermal and energy performance of a building is significantly influenced by heat ingress through its envelope which in turn is dependent on factors such as design, orientation and climatic zones. CSE conducted an analysis to study how

Figure 2: House taken for RETV analysis



Source: CSE

much difference a material switch can bring upon and found that the thermal properties of materials make a major impact on heat ingress.

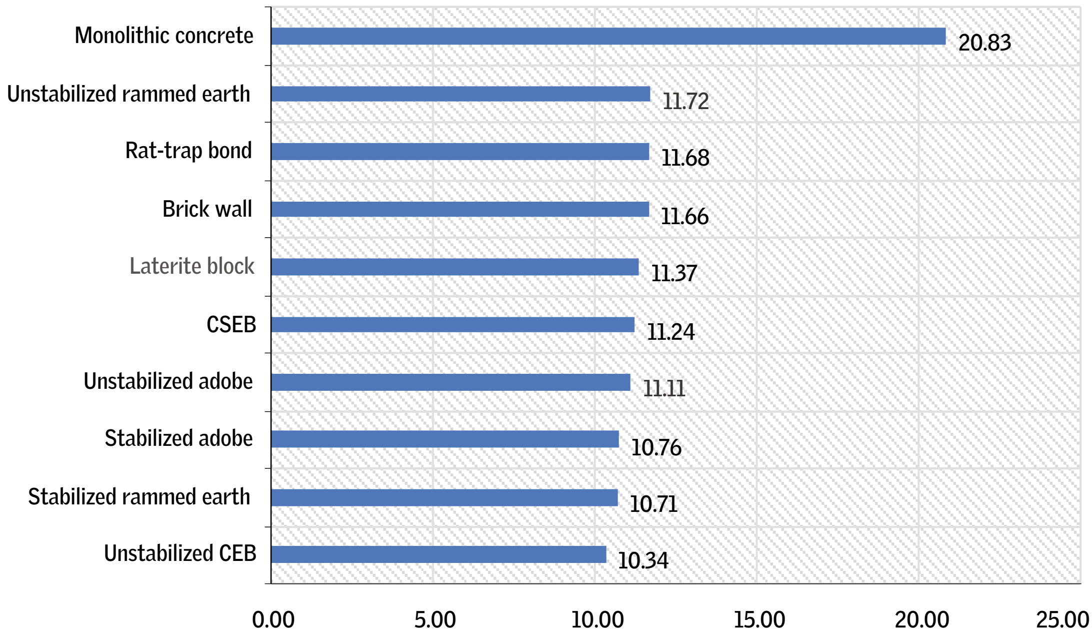
For this assessment, the Residential Envelope Transmittance Value (RETV) as mentioned in the Eco Niwas Samhita code was taken as an indicator for heat ingress. RETV characterizes the thermal performance of the building envelope (except roof). Limiting the RET value helps in reducing heat gains from the building envelope, thereby improving the thermal comfort and reducing the electricity required for cooling.[16] According to Eco Niwas Samhita 2024, the maximum permissible RETV for buildings in composite, hot-dry, warm-humid, and temperate climate zones is 15 W/m^2.

The study analysed a 2BHK (two bedrooms, a hall and a kitchen) house of 7.6 m by 6 m dimensions assumed to be in the composite climate of Delhi. The house design included four standard windows, one kitchen window, two ventilators, and a main door as part of the building's openings. To specifically assess the impact of heat ingress through the walls, all other parameters of the house were kept constant, with only the walling materials being varied for comparison.

When the sample dwelling was simulated with different walling materials, it achieved varying RETVs, reflecting the impact of each material on heat transfer. Simulations with 230-mm-thick unstabilized compressed earthen block brought out the best result as the RETV value came out to be at 10.34 W/m^2.

A 150-mm stabilized rammed earth wall and a 230-mm stabilized adobe block wall both recorded RET values of approximately 10.7 W/m^2, indicating strong thermal performance. Slightly higher values were observed for a 230 mm unstabilized

Graph 1: Heat ingress (with RETV as indicator) with different materials when building is simulated



Source: CSE analysis; thermal properties of the walling assemblies have been taken as per the 'National Database on Thermal Performance of Walling Technologies' by CEPT University.

adobe wall, which recorded 11.11 W/m^2, and a 230-mm compressed stabilized earth block (CSEB) wall at 11.24 W/m^2. Walls made of conventional 230-mm clay brick with 12-mm plaster on both sides, rat-trap bond brickwork with the same plastering, and a 124 mm unstabilized rammed earth wall showed RETV values in the range of 11.5 to 12 W/m^2.

This lack of knowledge amongst the general masses on the effect of such materials is evident in the fact that many construction companies display 'RCC wall construction' on advertisement banners for construction projects despite evidence suggesting that the monolithic concrete construction will have a weak defence against heat and allow more of it to enter the building in turn raising energy bills.

Sources: CSE

Photo credit: Sugeet Grover / CSE

Developers use RCC wall construction as a selling point

2

FROM MARGINS TO MAINSTREAM: A JOURNEY THAT NEEDS TO BE TAKEN UP

- Fusion technologies blend traditional materials like cob, adobe and wattle and daub with modern structures to combine resilience with environmental benefits.
- The lack of standardized data on physical and thermal properties limits the inclusion of alternative techniques in building codes.
- Several institutions and research bodies are working to scientifically validate and mainstream alternative technologies through performance evaluation and on-ground construction.
- Training institutes largely overlook non-conventional methods, leaving skilled masons in these techniques classified as 'unskilled'.
- Architectural experiments are challenging stereotypes by showing that alternative construction.

The Pradhan Mantri Awas Yojana (PMAY)-Gramin aims to build 20 million more houses by 2028–29 for households living in kutcha and dilapidated houses. With a minimum house size of 25 square metres (sq. m),[17] it maybe estimated that the country will add 500 million sq. m of built-up area through this scheme alone.

Moreover, the PMAY-Urban scheme plans to provide financial assistance to 10 million urban poor and middle-class families to construct, purchase or rent a house at an affordable cost in urban areas by 2029.[18] The scheme supports construction of houses with a minimum of 30 sq. m carpet area; it may be assumed that this works out to roughly 35 sq. m. built-up area. We are looking at a minimum of 350 million sq. m of built-up area being added under this scheme by 2029.

Past trends indicate that a significant portion—about 64 per cent[19]—of the housing stock has been built under the Beneficiary-Led Construction (BLC) vertical. In this model, the homeowner acts as the beneficiary and is responsible for the construction, using financial assistance provided by the government. As a result, of the 350 million square metres of housing stock being created (around 6.3 million houses), nearly 220 million square metres will be constructed based on decisions made directly by individual homeowners. This makes it essential for these decision-makers to be informed about the wide range of building materials available in the market. While conventional, concrete-intensive technologies have become mainstream, several non-conventional and alternative construction methods have also emerged on the periphery and merit greater attention.

Outliers attempting to answer the challenge

Attempts by construction centres, academic and research institutions, researchers, architects and practitioners dealing with non-conventional practices have come up with their own fusion technologies by marrying traditional and modern technologies to reap the advantages of the two approaches as, for instance, in the use of technologies such as cob, adobe blocks, wattle and daub used as non-load-bearing walls in a framed structure. This fusion allows for the structural elements to be sturdy enough to withstand extreme weather events as well as day-to-day weathering while still employing environmentally friendlier materials for the rest of the construction elements.

As the demand grows for building materials that deliver not only thermal comfort and energy efficiency but also structural stability, modern construction materials are increasingly supported by standardized reports and lab-tested performance data. These include metrics such as thermal conductivity, conductance, specific heat and compressive strength, which help establish their reliability and suitability for various applications. In contrast, alternative construction techniques, often rooted in local traditions and practices, have struggled to gain widespread acceptance due to a lack of standardization and formal documentation of their physical and thermal properties. This absence of verified data is a key reason why traditional methods are often excluded from official building codes. In recent years, however, several institutions and research bodies have stepped in to address this gap, working to scientifically validate and mainstream these alternative technologies through performance evaluation as well as actual on-ground construction using these technologies.

Centre for Advanced Research in Building Science and Energy (CARBSE), CEPT University has carried out thermal performance testing of multiple walling materials, including adobe, rammed earth, wattle daub, bamboo-crete, laterite blocks etc. The testing results established that the thermal properties of some non-conventional materials such as compressed earthen blocks were better than what had been previously understood and has been mentioned in the Eco Niwas Samhita code.

CSIR-Central Building Research Institute, Roorkee has innovated with fusion technologies and demonstrated many of these innovations and experiments in their rural technology park. The institute has also been instrumental in getting these technologies on ground and has work with Central and various state governments for implementation of these projects.

The Centre for Sustainable Technologies (CST) at the Indian Institute of Science (IISc), Bengaluru, conducts extensive research aimed at promoting sustainable technologies that are suited to local resource availability and living conditions. The Centre works on a wide range of alternative construction technologies, including the development and use of compressed earthen blocks (CEB) and machines for their production, stabilized CEB for structural masonry, and stabilized earth mortars. Other areas of research include steam-cured fly ash bricks, fly ash-lime-gypsum bricks, and CEB-incorporating non-organic solid wastes. CST also explores stabilized rammed earth, random rubble masonry with earth mortars, flowable earth mix concrete, unreinforced masonry vaults and domes, and composite jack-arch roof and floor systems. Additionally, the Centre focuses on filler slab roofing systems, cavity cool roofs, precast ferrocement or ferroconcrete products.

Institutions working towards filling the skill gap

In 2022, CSE conducted a study on sustainable self-built-housing[20] and found that skills to construct walls using traditional construction materials or techniques were acquired mainly through ancestral knowledge. The intricacies associated with wall constructions using non-conventional materials or techniques such as mathematical calculations, vertical alignment of wall, ideal height up to which the wall can be raised on each day of construction, mix proportions and composition etc. are most often passed on from one generation to another.

The country has a setup of Industrial Training Institutes, Industrial Training Centres as well as skilling centres for short-term courses under respective Sector Skill Councils. The study found that these institutes and skilling centres currently overlook alternative construction. Most construction-based training courses focus only on brick-and-mortar methods, leaving masons skilled in non-conventional practices classified as 'unskilled' and paid less. Centralized curricula under agencies such as the Directorate General of Training fail to reflect local construction methods, limiting the inclusion of diverse skills and innovation.

In the midst of this void, a few construction centres—both government and private—conduct workshops and training, and small courses on alternative construction techniques are held to ensure that more practitioners, enthusiasts and/or home buyers are trained in fusion techniques. These trainings courses build skills, keep the traditional construction knowledge alive and allow these centres to economically sustain themselves while carrying out construction projects.

Table 1: Centres offering trainings, workshops and short courses in alternative building techniques and natural materials in India

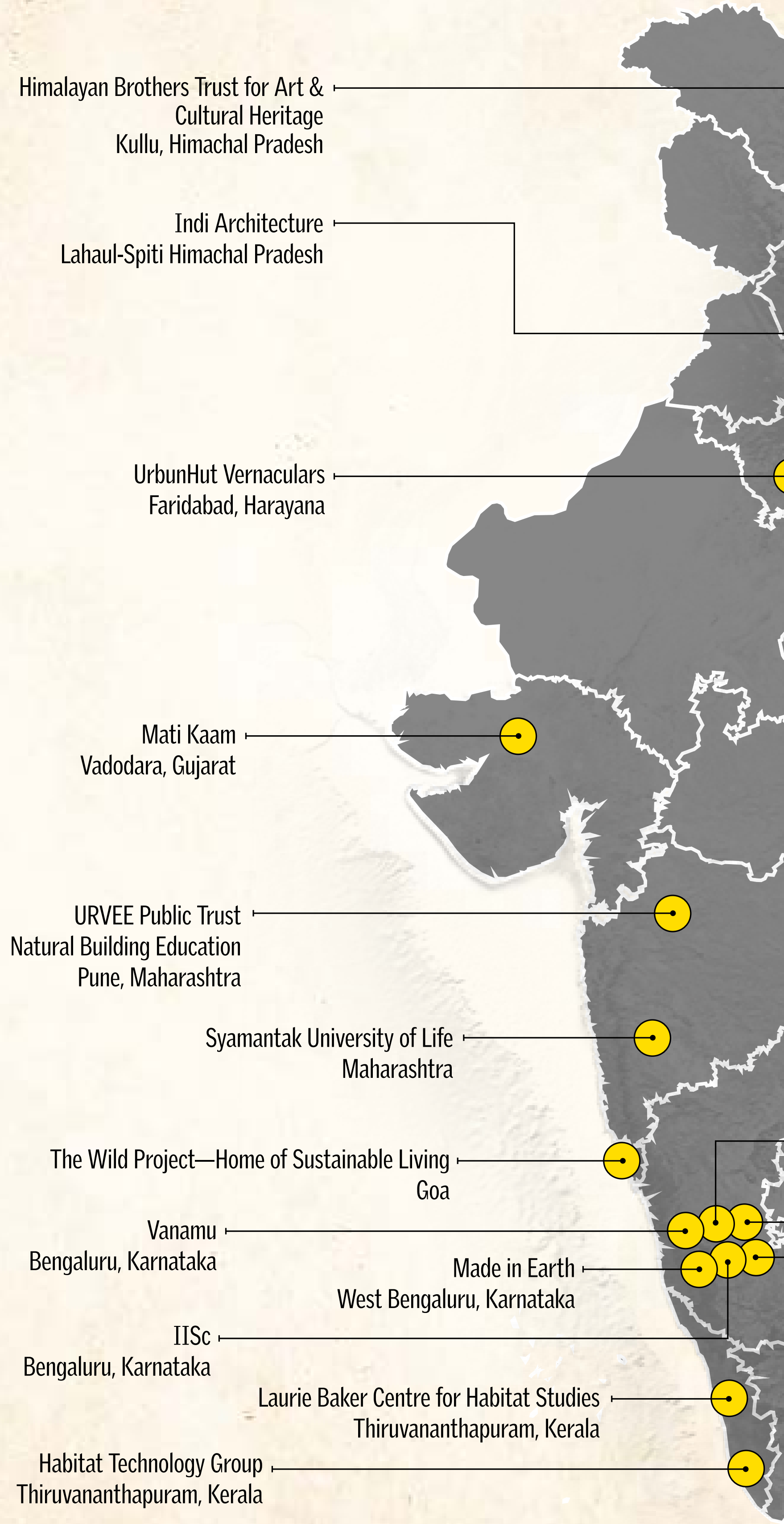
Training centres	Techniques and materials
Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala Location: Nooliyodu, Vilappilsala, Kerala https://www.lauriebakercentre.org/programms.php?type=1	• Adobe • Cob • Wattle and daub • Rubble masonry • Bamboo construction • Filler slab • Arches and vaults • Earth plastering • Bamboo-mud screening • CSEB/stabilized blocks • Rammed earth
Thannal Natural Homes Location: Tiruvannamalai, Tamil Nadu https://thannal.com/contact-us/	• Cob • Wattle and daub • Adobe • CSMB • Roofing techniques

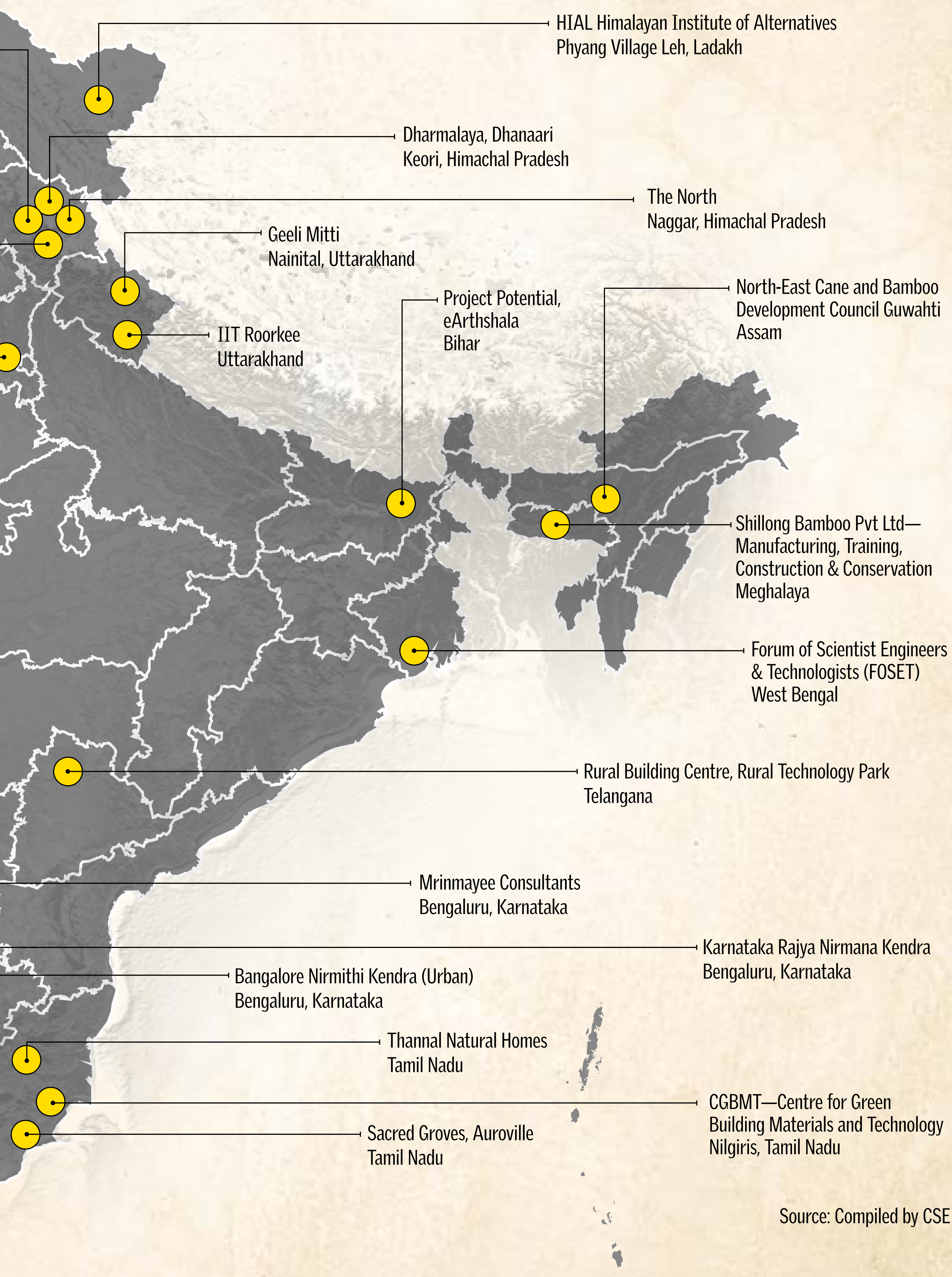
	(flat mud roof, Madras terrace roof, limecrete roof, khiru roof, adobe roof, pot tile roof/country tile roof, sandwich roof using terracotta tile) • Earthbag walls • Natural plaster techniques (cow dung, clay, lime washes, pozzolanic layers)
Himalayan Institute of Alternatives Location: Phyang Village Leh, Ladakh https://hial.edu.in/	• Rammed earth • Wattle and daub (soil–clay–straw mix) • Adobe • Mud plastering
Dharmalaya Location: Dhanaari, Keori, Himachal Pradesh https://dharmalaya.in/programmes/workshops-retreats-meditation-yoga-sustainability	• Adobe masonry • Cobe • Rammed earth • Slate roofing • Rubble masonry • Earthen finishes
Vanamu Location: No. 29, 1st Main, 1st A cross, Chikkabommasandra, GKVK, post, Yelahanka New Town, Bengaluru, Karnataka 560065 https://vanamu.org/	• Adobe • Rammed earth • Cob • Natural plasters and finishes (Rajasthani thaapi plaster, lohi plaster) • Jack arches, vaults and domes
Mrinmayee Consultants Location: 64 & 65/108, Rose Garden Road, Doresanipalya, Bilekahalli, Bannerghatta Road, Bengaluru, Karnataka 560076 https://mrinmayeeconsultants.com/workshops/	• Stabilized mud blocks • Adobe • Rammed earth • Masonry vault • Masonry dome
Urbunhut Vernaculars Location: 2053, Sainik Colony, Sector-49 Faridabad, Haryana 121001 https://www.urbunhut.com/rammed_earth_construction_workshops.php	• Rammed earth • Adobe • Cob • CSEB
Habitat Technology Group Location: Grandhasala Rd, Near Sree Saraswathi Temple, Poojapura, Thiruvananthapuram, Kerala 695012 https://www.habitattechnologygroup.org/#	• Adobe • Rammed earth • CSEB • Earthbag • Funicular shells • Bamboo construction
Geeli Mitti Location: Geeli Mitti Farms, Mahrora Village, Pangot P.O., Nainital, Uttarakhand 263002 https://geelimitti.in/ Watch the videos for more information: https://www.youtube.com/watch?v=S057Qs2ov5g&t=6s (QR code to be inserted) https://www.youtube.com/watch?v=S057Qs2ov5g (QR code to be inserted)	• Cob • Wattle and daub • Rammed earth • Strawbale • Earthbag • Stone • Bamboo
Himalayan Brothers Trust for Art & Cultural Heritage Location: Kullu, Himachal Pradesh	• Kath kuni • Timber joinery and wood–stone Construction

The North Location: Naggar Castle Road, Opp. Castle Parking, Naggar, Himachal Pradesh 175130 https://thenorth.in/workshops	• Adobe • Cob • Rammed earth • Wattle and daub • Kath kuni • Dhajji dewari
Mati Kaam Location: Vadodara, Gujarat	• Adobe • Cob • Rammed earth • Wattle and daub
Karnataka Rajya Nirmana Kendra Location: Sy. no. 18, near Sambram College, Chikkabetahalli Vidyaranyapura, Bangalore 97 https://ghtc-india.gov.in/IHTM/Content/img/company-logos/pdf/31.pdf	• Stabilized mud blocks for walling • Funicular shells • Ferrocement channels and trusses for roofing • Filler slab for roofing • Jack arch for structural masonry over openings as alternative to lintel/beam • Hollow concrete blocks, Interlocking blocks for walling • Fly ash-based bricks, blocks or interlocking blocks for walling
Bangalore Nirmithi Kendra (Urban) Location: DC Office Complex, KG Road, Bengaluru, Karnataka 560009 https://bnku.co.in/	• Stabilized mud blocks, concrete block (hollow and solid) • Rat trap bond • Fly ash blocks • Filler slab • Ferrocement channel • Jack arch roofing • Mud block roofing • Ribbed slab roofing • Mud block jack arch roofing • High volume fly ash roofing
Sacred Groves Location: Sacred Groves, Auroville, Tamil Nadu https://auroville.org/page/sacred-groves-av	• Adobe • Cob • Wattle and daub • Mud plaster • Timber-framed clay straw wall • Earthcrete • Shotcrete
Made in Earth Location: West Bangalore https://madeinearth.in/	• Wattle and daub • Adobe • Rammed earth • Natural plasters (clay and lime) • Tadelakt (Moroccan lime plaster)
URVEE Public Trust—Natural Building Education Location: Pune, Maharashtra https://www.facebook.com/urveepublictrust/	• Rammed earth • Adobe • Wattle and daub • Vault-building
Syamantak—University of Life Location: 163, At Post Dhamapur, Tal: Malvan, Dist: Sindhudurg, Maharashtra https://universityoflife.org.in/natural-construction/	• Clay • Lime • Tadelakt, araish and base natural plaster

IIT Roorkee Location: Roorkee, Uttarakhand https://www.varunthautam.com/2019/06/mexican-dome-workshop-iit-roorkee/	• Mexican dome vaults without formwork • Earth, mud, lime, stone and traditional bricks
Indian Institute of Science (IISc) Location: Bangalore https://iisc.ac.in/locations/iisc-challalkere-campus/	• Rubble masonry • Compressed earth blocks • Rammed earth • Stabilized earth mortar • Cavity-cool roofing systems
The Wild Project—Home of sustainable living Location: Goa https://www.instagram.com/p/DKSETKlgxCH/?igsh=ZXhscmdtaDcxZTZn	• Earthen construction • Natural plasters
FOSET Location: West Bengal https://foset.org.in/	• Bamboo construction
Rural Building Centre, Rural Technology Park Location: Telangana https://nirdpr.org.in/rtp.aspx	• Arch foundations • Rat-trap bonding brick work for walling • Stone masonry walling in super structure • Adobe blocks • Cement stabilized mud blocks • Rammed earth walling and columns • Wattle and daub walling • Mangalore tile roofing • Conical tile arch roofing • Filler slab • Arches • Ferrocement channel roofing • Brick dome roof • Ferro cement arch roofing • Bamboo corrugated sheet roofing • Pre-cast RCC panels over pre-cast joists • Mud plastering to the mud block walls • Non-erodeable mud plaster • Lime plaster • Corbelling windows lintel • Bamboo-panelled doors and windows
North-east Cane and Bamboo Development Council Location: Guwahati, Assam https://necbdc.in/services-portfolio/	• Bamboo construction
Shillong Bamboo Pvt Ltd—Manufacturing, Training, Construction & Conservation Location: Shillong, Meghalaya https://bamboosahihai.com/place/shillong-bamboo/	• Bamboo construction
CGBMT—Centre for Green Building Materials and Technology Location: Nilgiris, Tamil Nadu https://www.cgbmt.org/	• Bamboo construction

MAP 1
INSTITUTES/CENTRES OFFERING TRAININGS, WORKSHOPS, SHORT COURSES IN ALTERNATIVE BUILDING IN INDIA





Source: Compiled by CSE

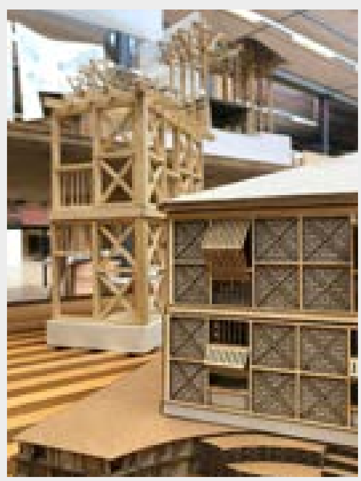
Educational institutions nationally and internationally have also played a role in amplifying the knowledge associated with non-conventional materials alive through workshops, summer schools, elective subjects etc.

CEPT University, Ahmedabad, held a summer school in 2025 on 'Re-imagining Vernacular Architecture of Kangra Valley'. Through the programme, architecture students explored how to adapt indigenous building techniques to modern-day contexts. Working with materials like mud brick, stone, bamboo, timber and slate, students revived techniques that hold the key to carbon-conscious, regionally appropriate construction.[1]

Summer school by CEPT University: Re-imagining Vernacular Architecture of Kangra Valley

Source: https://www.linkedin.com/pulse/cept-summer-course-2025-re-imagining-vernacular-architecture-1ewqf/

The Architecture and Society Unit at the University of Liechtenstein conducted, as part of their summer semester 2025 Urbanism, a design studio in which 20 students developed design proposals for the construction of a boarding school for about 500 children in Singuni, Uttarakhand, India. The studio focused on the changes to vernacular architecture in the course of globalization. What regenerative resources are available? What craftsmanship still exists? How can old and new building methods be combined and the dichotomy between 'kutcha' and 'pukka' houses overcome?



The Architecture and Society Unit at the University of Liechtenstein taught a course based on traditional construction in Singuni, Uttarakhand, India

Several other educational institutes, including the following, have carried out similar programmes in the past:

- Vellore Institute of Technology in Tamil Nadu conducted a programme for its third-year students on use of materials such as mud, earth, stone, bamboo and thatch.
- DY Patil University in Navi Mumbai conducted a workshop on earthen construction techniques with Hunnarshala foundation. It involved hands on training on adobe-brick making, wattle and daub walls, and mud roll finishes.
- The National Association of Students of Architecture organized a workshop on COB wall-building and natural material construction in Trichy.
- The Bhanuben Nanavati College of Architecture for Women in Karve Nagar, Pune, organized a hands-on workshop to equip students with practical skills and knowledge about sustainable building materials, with a focus on bamboo. The workshop covered bamboo joinery techniques, and included the construction of a bamboo pavilion.
- The CARE School of Architecture, Trichy, Tamil Nadu, conducted a workshop on natural materials in 2025 as part of their summer school.
- Workshops in shallow dome and bamboo construction were recently conducted by NIT Rourkela, Guru Nanak Dev Engineering College Ludhiana, and Techno India College, Kolkata among others.

Source: https://www.linkedin.com/pulse/cept-summer-course-2025-re-imagining-vernacular-architecture-1ewqf/

Alternative architectural practices have played their part in building structures that defy the norm

A small number of architectural firms and design practices have been experimenting with alternative or hybrid construction technologies, blending traditional methods with modern innovations. However, the demand for such construction remains limited and is largely driven by a niche clientele. Despite this limited uptake, these projects play an important role in changing public perception. They help

Photo credit: Sugeet Grover / CSE

Housing society Malhar in Bengaluru uses compressed earthen blocks and double roof challenge the stereotype that such technologies are only suitable for low-income or rural housing. In fact, some of these buildings because of their aesthetic appeal, sustainability credentials or innovative design have become landmark examples. They serve as proof of concept and help build aspirations, demonstrating that alternative construction techniques can be desirable, modern and suited for a wider audience.

Photo credit: Sugeet Grover / CSE

Housing society Malhar in Bengaluru uses compressed earthen blocks and double roofs

Photo credit:: Sugeet Grover / CSE

A house in Bhilwara, Rajasthan, that uses stone walls

Source: https://www.studioshunya.com/

Photo credit: Sugeet Grover / CSE

The visitors' centre in Auroville, Tamil Nadu, uses compressed earthen blocks

Photo credit: Sugeet Grover / CSE

The Mud House guesthouse in Bolpur, West Bengal, made with adobe blocks, mud plaster, wooden frame and tiled roof

A house in Chittorgarh, Rajasthan, that uses thatched roof and rammed earth walls

Source: https://www.studiosh unya.com/

Photo credit:: Sugeet Grover / CSE

Krushi Bhawan, a government facility in Bhubaneswar, Odisha, uses laterite stone

Unfortunately, only a few architectural practices working with alternative construction have been able to scale up or sustain their work over time. One of the main challenges they face is the limited demand from the general public. While such projects may receive interest from a niche segment, the broader market continues to rely on conventional methods, driven by familiarity, speed and existing supply chains.

Without widespread acceptance or a larger customer base, these practices often struggle to maintain steady work or achieve financial viability. The absence of a critical mass willing to adopt or invest in alternative technologies makes it difficult for these firms to grow or even survive in the long run. As a result, many promising efforts in the space remain isolated, unable to influence the mainstream construction landscape.

Why this compendium?

The material choices state governments, individual owners and the construction industry makes will have a huge impact on the country's carbon budget as well as the thermal comfort and energy efficiency of buildings. As more voices demand alternatives to our carbon-intensive choices, erstwhile non-conventional technologies pushed to the fringes are raring to make a comeback. The transition however requires knowledge. This guidebook is an attempt to make the decision maker aware of the less-conventional techniques and bring them to the mainstream.

Overview of technologies

In the past, there have been multiple attempts by agencies, institutes and bodies such as Building Materials and Technology Promotion Council, Central Building Research Institute, IIT Delhi, United Nations Development Programme and Ministry of Rural Development to raise awareness about construction technologies and materials via multiple publications. While some of these technologies are heavily concrete dependent, some are not and can be viable alternatives to conventional construction.

This compendium by no mean covers the plethora of non-conventional construction materials and the infinite number of combinations that they can form to build low-carbon construction. It takes selected technologies and compiles them in a format that can be easily understood by the reader. The technologies themselves have been grouped into three broad categories: walling, roofing and intermediate floor and roof coverings. These groupings have been further subdivided as follows:

Walling technologies

- ***Brick- and block-based construction:*** This method involves placing blocks/bricks one by one, bonding them together with mortar or binder to form walls and structures. The strength comes from the layered arrangement and the bonding material.
- ***Earth-based construction technologies:*** These use soil as the main material, often shaped into blocks, packed into frames, or applied directly onto walls. The soil is made from various components and the different sizes of the soil particles have different properties. Hence the proportion of organic matter, pebbles, gravel, sand, silt and clay imparts each soil its unique properties and applicability for different earth-based construction. The earth can be used alone or mixed with straw or fibres for extra strength and binding. In some cases it may be stabilized with cement, lime or other binding materials. Earth-based construction technologies are amongst the oldest ways of building, with many techniques and variations found across the globe.
- ***Wood- and stone-based construction technology:*** This construction method combines wood and stone to create sturdy and flexible structures. In techniques like *dhajji dewari*, a timber lattice is filled with masonry units, allowing the structure to sway and absorb movement. *Kath-kuni* uses alternating layers of wood and stone, interlocked without mortar, creating thick, durable walls. Both methods rely on local materials and traditional joinery, offering stability in mountainous terrains.
- ***Bamboo-based construction technology:*** Bamboo is a versatile, fast-growing material used for making strong and flexible wall systems. In these technologies,

Photo credit: Sugeet Grover / CSE

Different components of soil based on particle size

Source: Earth Institute, Auroville

bamboo stems are woven, tied or framed to create wall panels or supports. These bamboo structures can then be combined with mud, plaster or other fillers to complete the wall.

- ***Blocks from recycled agriculture waste or biomass:*** These use blocks made from recycled agricultural waste or biomass like straw, husk, hemp, bagasse etc. The waste is processed and compacted into block or panel forms that can be stacked to make walls. This method turns farm byproducts into usable building units, often reinforced with natural or binding materials.

Roofing and intermediate floor technologies

- ***Flat roofs and intermediate floors:*** Flat roofs or floors are mostly level surfaces often with just a slight slope to let rainwater drain. They are built using straight, horizontal elements that span between walls, giving a flat surface on top. They can work as flat roofs or intermediate floors.
- ***Curved roofs and intermediate floors:*** Curved roofs or floors have a rounded shape underneath—like a shallow dome or arch—that helps spread the weight of the roof more evenly. The top can still look flat, but the curve underneath is what supports it. They can work as flat roofs or intermediate floors.
- ***Pitched roof:*** Pitched roofs are sloped on one or both sides, forming a triangle-like shape. The angled design helps rainwater slide off easily and is common in areas with heavy rain.

Roof coverings

These comprise materials and/or technologies such as tiles, sheets or thatch laid over a roof structure to complete the outermost layer. They help finish the roof surface, protect the interior from external elements like rain and sunlight, and influence the building's appearance. Unlike solid roofing systems, these coverings are not meant to bear much loads or function as walkable floors—they simply complete the roof by sitting over a supportive framework like rafters or purlins.

3

CONSTRUCTION TECHNOLOGIES

Walling technologies

- Brick- and block-based construction
- Earth-based construction technologies
- Wood- and stone-based construction technology
- Bamboo-based construction technology
- Blocks from recycled agriculture waste or biomass

Roofing and intermediate floor technologies

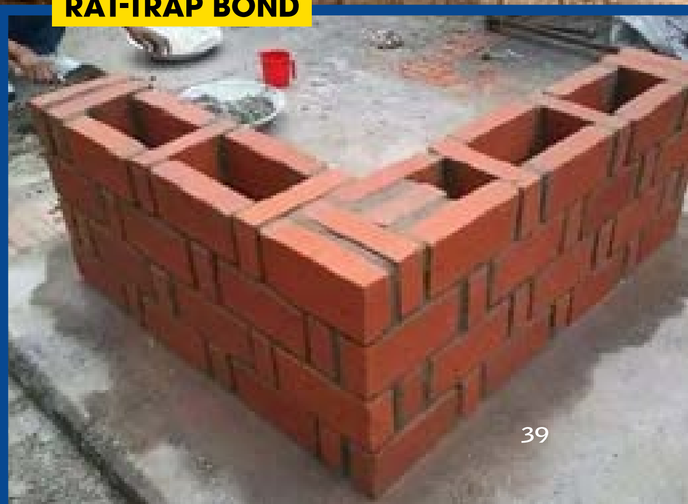
- Flat roofs and intermediate floors
- Curved roofs and intermediate floors
- Pitched roof

Roof coverings

BRICK- AND BLOCK-BASED CONSTRUCTION

TERRACOTTA BLOCKS

RAT-TRAP BOND



RAT-TRAP BOND

Rat-trap bond is a brick masonry technique that uses standard 230 x 115 x 75 mm bricks to construct walls. The bricks are laid on their edges instead of being laid on their wider faces, resulting in a 75 mm hollow space within the wall.

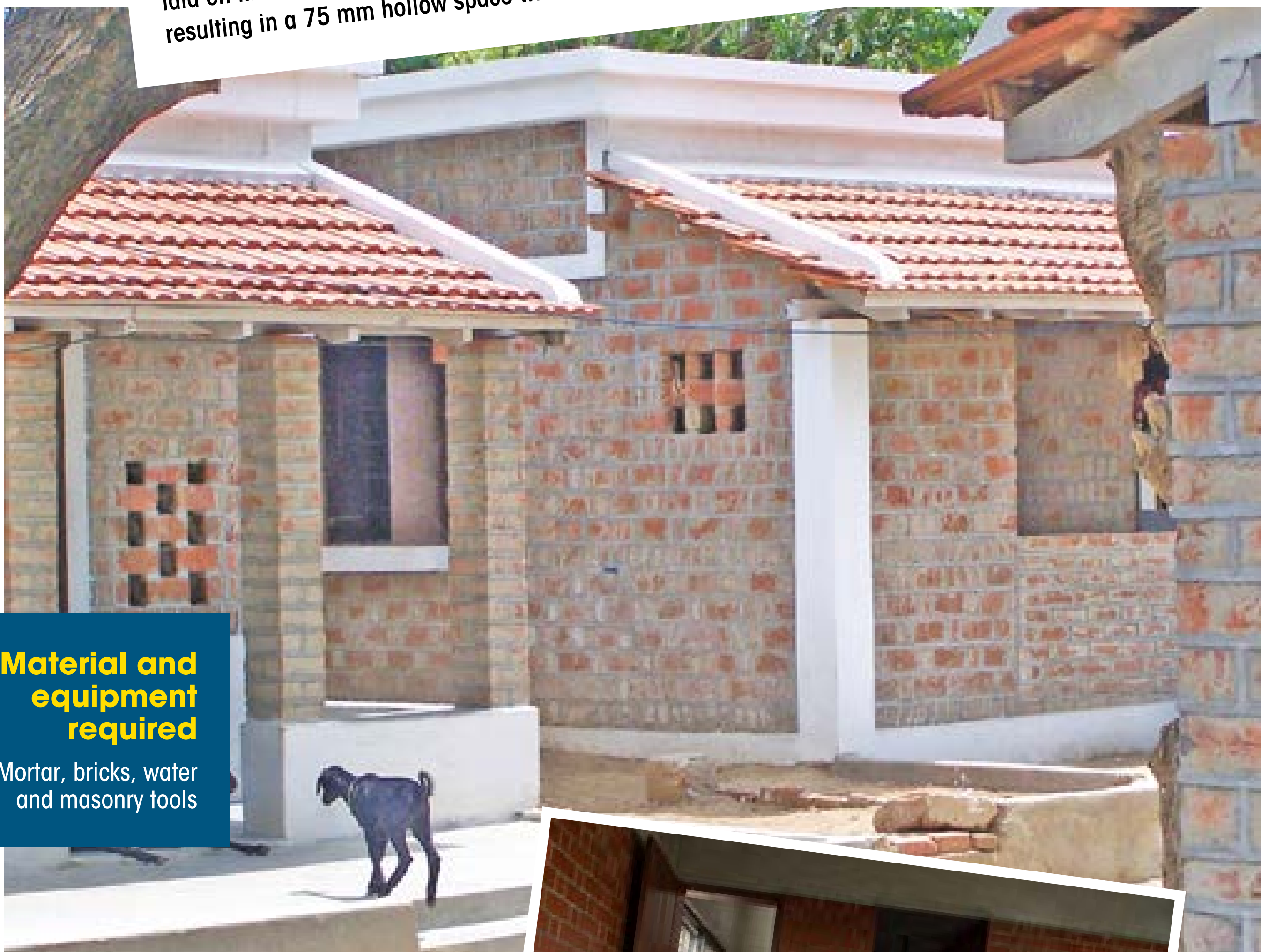


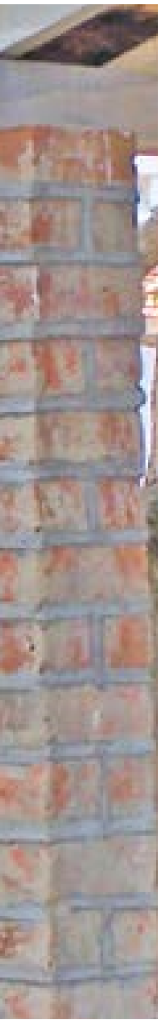
Photo courtesy: *Building Wise*, CSE

Material and equipment required

Mortar, bricks, water and masonry tools

Photo courtesy: volzero.com

Photo courtesy: dailycivil.com



CHARACTERISTICS

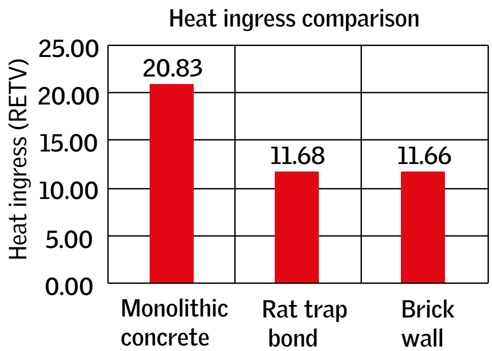
THERMAL PERFORMANCE

The heat ingress analysis revealed that a 255-mm-thick rat trap bond wall had around 44 per cent less heat ingress than a 150-mm monolithic concrete wall. It provided similar thermal performance to a conventional brick wall.

MATERIAL SAVINGS

A rat-trap bond consumes approx. 20–35 per cent less bricks and 30–50 per cent less mortar.[1] One m^3 of normal brick wall consumes approx. 550 bricks; in comparison the number of bricks work out to 470 in a rat-trap bond wall.[2]

Graph 2: Comparison of heat ingress: monolithic concrete, rat-trap bond and brick wall



BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo credit: Sugeet Grover / CSE

Laurie Baker Centre, Thiruvananthapuram, Kerala

1. Indian Coffee House, Thiruvananthapuram, Kerala
2. Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala
3. Rural Technology Park, CBRI–Central Building Research Institute, Roorkee, Uttarakhand
4. Centre For Development Studies, Thiruvananthapuram

WHERE CAN I LEARN MORE ABOUT THIS?

1. Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala
2. Rural Building Centre, The National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad
3. Hunnarshala Foundation, Bhuj, Gujarat
4. Nirmithi Kendra, Karnataka

SIMILAR TECHNIQUES

TERRACOTTA BLOCKS

TO LEARN MORE, see page 42

Sources:

1. Joshi, A., Rakholiya, K., Rangani, J., Gangode, H., Khan, M., Rao, M.V., Ahire, G. and Sarode, K., 2017, 'Rat trap bond masonry', International Journal of Advance Research in Science and Engineering, Vol. 6, Issue No. 02, February, https://www.ijarse.com/images/fullpdf/1487863316_N577ijarse.pdf

2. Ibid.

Photo courtesy: volzero.com

Photo courtesy: wienerberger.in

Material and equipment required

Terracotta blocks, mortar, water and masonry tools

TERRACOTTA BLOCKS

Terracotta blocks, also known as porotherm blocks or thermobrick, are composed primarily of clay. These blocks can be used in load-bearing construction (mostly G+1) as well as for non-load-bearing/infill/partition wall applications. Load-bearing blocks have vertical perforations while non-load-bearing ones have horizontal perforations.

Photo credit: Garima Kaushal

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

CHARACTERISTICS

- The perforations in the terracotta blocks facilitate thermal insulation resulting in cooler interiors in hot seasons and warm interior conditions in cold seasons.[1]
- The speed of wall construction increases when using terracotta blocks. This is attributed to their lightweight nature and ease of handling.
- The perforations in these blocks can be filled with mineral wool to provide further insulation.[2]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Apna Ghar construction system, Nagpur, Maharashtra
2. Jindal Ceramica: Offer training sessions to learn to build with thermobricks

Photo courtesy: archdaily.com

Terramater Gallery, Amritsar, Punjab

1. Tarang Pavilion, Gandhinagar
2. Terramater Gallery, Amritsar, Punjab (*see photograph*)

Sources:

1. https://theconstructor.org/construction/porotherm-bricks-properties-applications/36837/

2. https://www.jindalceramica.com/perforated-clay-hollow-blocks/

SIMILAR TECHNIQUES

RAT-TRAP BOND

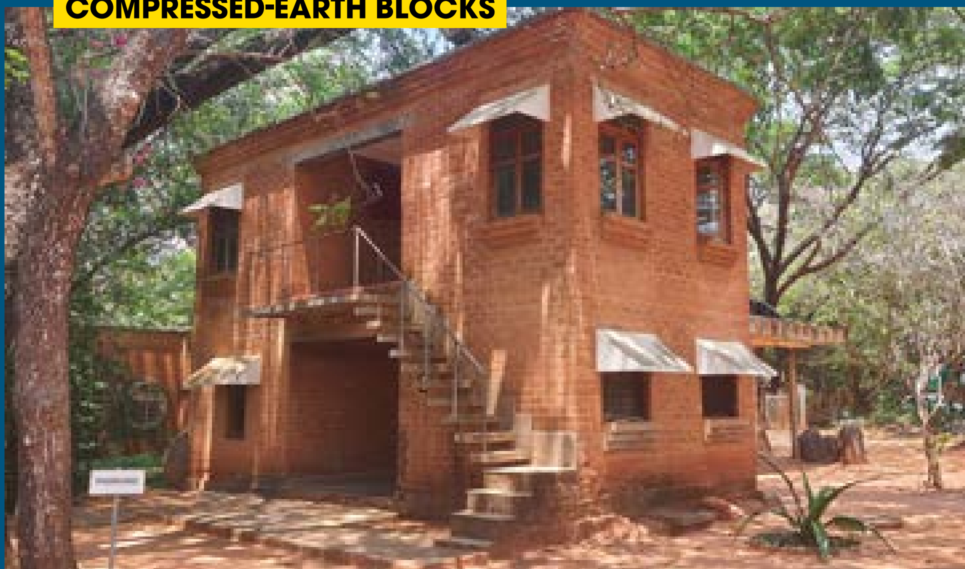
TO LEARN MORE, see page 40

EARTH-BASED CONSTRUCTION

RAMMED EARTH

ADOBE BRICK

WATTLE AND DAUB



COMPRESSED-EARTH BLOCKS

COB WALL

RAMMED EARTH

Construction of rammed earth walls entails compacting optimum moisture content subsoil with adequate proportions of sand, gravel and clay, with or without cement stabilization. Soil mix is poured into the formwork to a depth of 10–250 mm (4–10 inches) and compacted to about 50 per cent of its original volume. The soil is compacted in batches or courses to gradually build the wall up to the formwork's top. Rammed earth's compressive strength is determined by factors such as soil type, particle size distribution, amount of compaction and moisture content.[1]

Photo credit: Sugeet Grover / CSE

Material and equipment required

1. Formwork (ply board sheet, metal pipes, thin rods to insert in metal pipes, 4 cm x 5 cm metal rods, screws)
2. Soil mixture: Clay, cement, sand, aggregate and cement (optional)
3. Tamper/rammer

Photo courtesy: lotusflowertrust.org

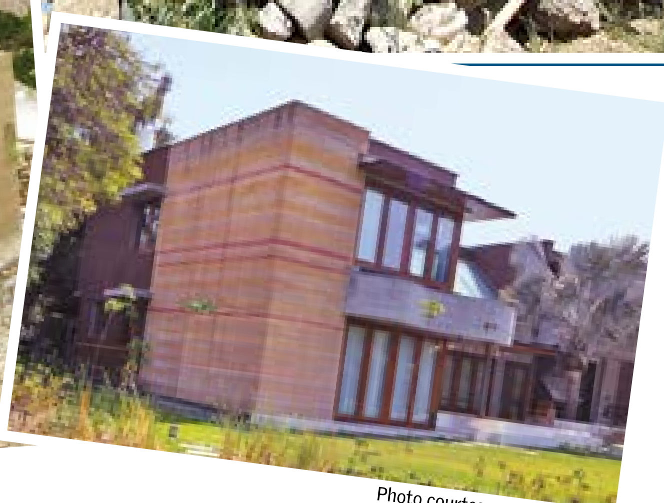
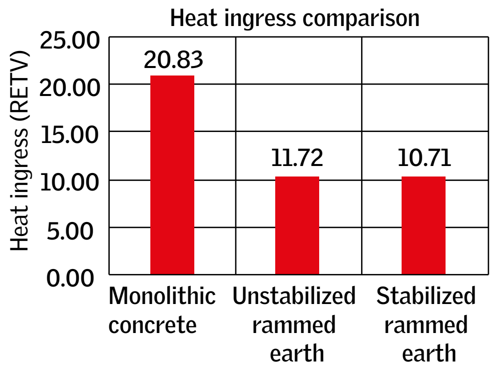


Photo courtesy: archdaily.com

CHARACTERISTICS

- The clay-to-sand ratio has the greatest contributing effect on how well an earth wall will perform.
- The best soil for rammed earth is preferably sandy or gravely rather than clayey.[2]
- Ideal soil composition appropriate for the technology: ~50–60 per cent sandy, ~15 per cent gravel, ~15 per cent silt and ~20 per cent clay.[3]
- Thermal performance: The heat ingress analysis revealed that a house with 150-mm-thick stabilized rammed earth walls had ~48 per cent lower heat ingress while 124-mm unstabilized rammed earth walls had roughly 44 per cent lower heat ingress when compared to a house with 150-mm-thick monolithic concrete walls.

Graph 3: Comparison of heat ingress: monolithic concrete and rammed earth



WHERE CAN I LEARN MORE ABOUT THIS?

1. Hunnarshala Foundation, Bhuj, Gujarat
2. Sankalan-Hunnarshala, Gujarat
3. Urbunhut, Faridabad, Haryana
4. Thannal Natural Homes, Tamil Nadu
5. Auroville Earth Institute, Auroville, Tamil Nadu
6. Vanamu, Bengaluru, Karnataka
7. NIRD&PR, Hyderabad
8. Mrinmayee Consultants, Bengaluru, Karnataka
9. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
10. North, Naggar, Himachal Pradesh
11. Matikaam, Vadodara, Gujarat
12. Studio Shunya, Greater Noida, UP
13. Habitat Technology Group, Thiruvananthapuram, Kerala

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo credit: CSE

Anil Agarwal Environment Training Institute, Neemli, Alwar, Rajasthan

1. Anil Agarwal Environment Training Institute, Neemli, Alwar, Rajasthan (*see photograph*)
2. Lachen Palkar Palace, Leh
3. Thiksey Monastery, Ladakh
4. Aanandaa Permaculture Farm, Haryana, India
5. Kaza Community Centre, Spiti Valley, India
6. Himalayan Institute of Alternatives Ladakh, Leh, Ladakh
7. Sankalan-Hunnarshala, Gujarat
8. Karigarshala, Bhuj, Gujarat
9. The Students' Educational and Cultural Movement of Ladakh (SECMOL), Leh, Ladakh

For more information and to watch video **scan QR code**

SIMILAR TECHNIQUES

COMPRESSED EARTHEN BLOCKS

TO LEARN MORE, see page 50

Sources:

1. Anon. 2021, Compendium of Building Technologies, Central Building Research Institute and Building Materials and Technology Promotion Council

2. Auroville Earth Institute, https://dev.earth-auroville.com/traditional-rammed-earth/, last accessed in July 2025

3. Auroville Earth Institute

STEP-BY-STEP GUIDE

RAMMED EARTH WALL

1

Begin by excavating soil from the site if it is suitable for construction. Using on-site soil reduces energy, time and overall construction costs. The ideal soil for rammed earth should be sandy or gravelly rather than clayey.

2

Prepare the soil mixture by combining clay, sandy soil, aggregates and cement if stabilization is required (for soil proportions, see 'Material specifications'). Mix the components thoroughly by hand until a uniform consistency is achieved.[4]

3

Use plywood sheets and pipes to construct formwork for the rammed earth mixture, ensuring sufficient distance between the sheets according to the desired wall thickness.[5]

4

To hold the ply sheets together, first insert a thin rod through the pipes

5

Then, pass the pipes through the ply boards.

6

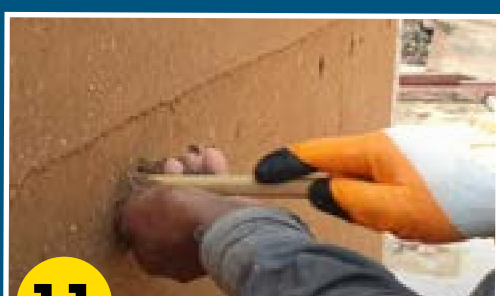
Tighten them at both ends to secure the structure in place.

7 Fix additional support by placing 4 cm x 7 cm pipes on either side of the plywood sheets

8 Once the formwork is secured, wall construction can be begun by pouring the prepared soil mixture into the formwork

9 After pouring each layer, begin the ramming process using tampers. Due to compaction, a 12-cm layer will compress down to about 9 cm. The pounding should continue until a metallic sound is heard, indicating that the layer has been compacted sufficiently and the next layer can be added.

10 After the wall is complete, the formwork can be removed the next day



11 Carefully knock the metal pipes loose and extract them.

12 Fill the holes left behind by the pipes with the same soil mixture and gently hammer them back into place, ensuring a smooth and uniform finish.

Sources:

1. *Down to Earth*, 'How to build a rammed earth house', https://youtu.be/HkX5GSZCQVM?si=0MKLSLCooyAPuJpa
2. *Down to Earth*, 'How to make a Rammed Earth Wall, Aanandaa Permaculture Farm' https://youtu.be/AO8Cqk598wY?si=PF7ya3mXH5Uxkxaf

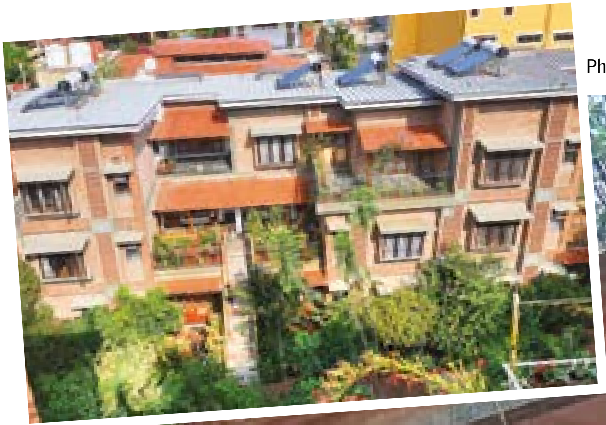
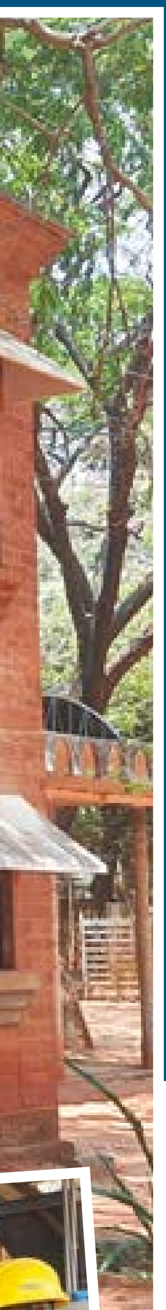


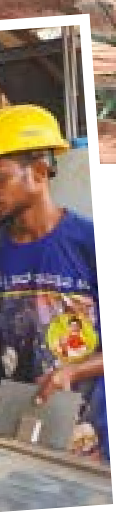
Photo credit: Sugeet Grover / CSE

COMPRESSED EARTH BLOCKS

Compressed earth blocks (CEBs) are made from a mix of soil, sand, and water, and can be stabilized with up to 5 per cent cement to improve strength—known as compressed stabilized earth blocks (CSEBs). These are pressed manually or mechanically and cured for 28 days. The blocks can be solid, hollow, round or customized depending on the application and can be used for walls, columns, floors, and even roofs. Since they can use site soil, transport costs are reduced, but their feasibility depends on local soil suitability.

Photo credit: Sugeet Grover / CSE

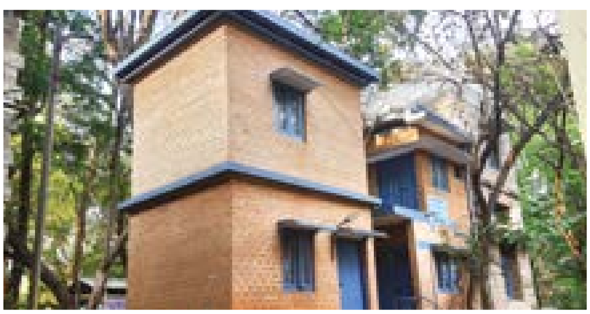




CHARACTERISTICS

- Ideal CSEB soil should have less than 1 per cent organic matter, 5–15 per cent clay, 60–70 per cent sand and 15–35 per cent silt, with total silt and clay at 30–40 per cent. Soil must also be non-expansive.[1]
- Since CSEBs are not burnt, they help regulate indoor temperature by absorbing and releasing moisture. As temperatures rise, moisture evaporates, cooling the space; when it drops, condensation releases heat, keeping interiors warm.[2]
- Construction with CSEB uses up to 50–60 per cent less mortar than conventional masonry.[3] Interlocking CSEB blocks further reduce or eliminate mortar use, cutting material needs and speeding up construction.[4]
- CSEB construction should avoid topsoil and organic soils. Cement works better for sandy soils (50 per cent sand, 20 per cent clay) for quicker strength gain, while lime suits clayey soils (35 per cent clay, 30 per cent sand) for stronger, though slower-setting, blocks.[5]
- Thermal performance: The heat ingress analysis revealed that a house with 230-mm-thick CSEB walls had ~46 per cent lower heat ingress while 230-mm unstabilized CEB walls had ~50 per cent lower heat ingress when compared to a house with 150-mm-thick monolithic concrete walls.

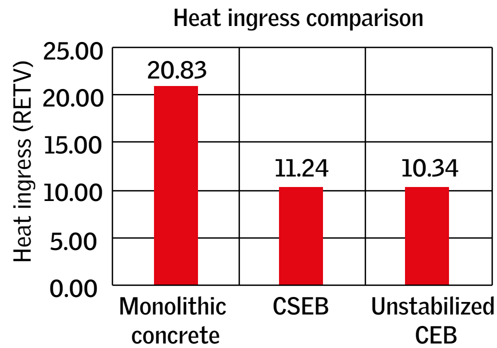
BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE



Indian Institute of Science, Centre for Sustainable Technologies, Bengaluru

1. **IISc, Centre for Sustainable Technologies, Bengaluru (*see photograph*)**
2. **Sharanam Centre for Rural Development, Pondicherry, Tamil Nadu**
3. **Technology and action for rural advancement, Ghitorni, New Delhi**
4. **Butterflies Resilience Centre, New Delhi**
5. **Development Alternatives world headquarters, New Delhi**
6. **Sankalan-Hunnarshala, Gujarat**
7. **Eco-tourism cottages at Sonapani Himalayan Village, Uttarakhand**

Graph 4: Comparison of heat ingress: monolithic concrete and compressed earthen blocks



WHERE CAN I LEARN MORE ABOUT THIS?

1. Auroville Earth Institute, Auroville, Tamil Nadu
2. Urbunhut, Faridabad, Haryana
3. Thannal Natural Homes, Tiruvannamalai, Tamil Nadu
4. Earth Block India, Bangalore
5. Sankalan-Hunnarshala, Gujarat
6. Mrinmayee Consultants, Bengaluru, Karnataka
7. Habitat Technology Group, Thiruvananthapuram, Kerala
8. Nirmithi Kendra, Karnataka

SIMILAR TECHNIQUES

RAMMED EARTH

TO LEARN MORE, see page 46

Sources: 1. Niazi Z., Khanna P., Gupta S. and Sirohi R., 2020, 'Stabilized Compressed Earth Block (SCEB)—Production and Construction Guide' Development Alternatives. https://www.oneplanetnetwork.org/sites/default/files/from-crm/17-cb11609636b1c23d393f79 8269a54924_STABILIZED_COMPRESSED_EARTH_BLOCK_%2528SCEB%2529_-_Production_and_Construction_Guide.pdf, last accessed in July 2025

2. Ministry of Housing & Urban Affairs Government of India, https://ghtc-india.gov.in/IHTM/Content/img/company-logos/pdf/3.pdf, last accessed in July 2025

3. Ibid.

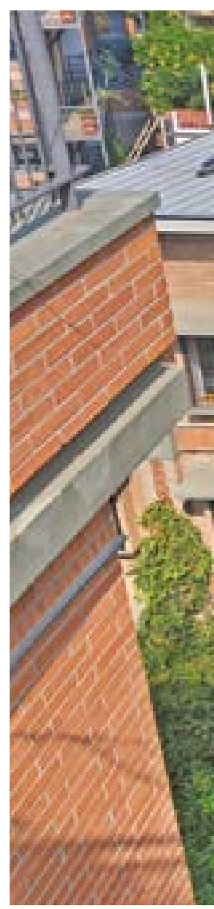
4. Ibid.

5. Auroville Earth Institute, https://dev.earth-auroville.com/compressed-stabilised-earth-block/ last accessed in July 2025

CASE STUDY

MALHAR IN BENGALURU

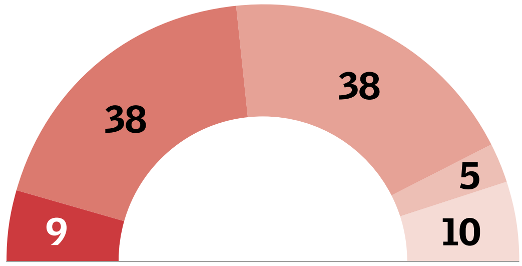
The Malhar project by GoodEarth in Bengaluru is a residential community with a total built-up area of 135,367.36 sq. m. The project has used roughly 15,000,000 compressed stabilized earthen blocks so far. Two types of blocks have been used, one a coloured block used mainly for external application and the other one used where the wall is plastered.



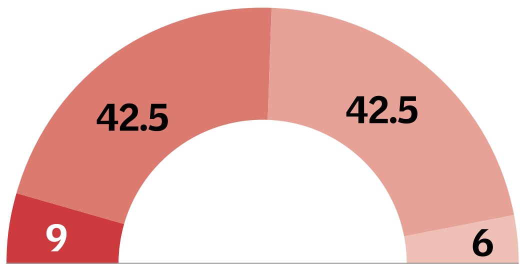
Graph 5: **Material composition of coloured and normal earthen blocks**

● Cement ● Sand ● Normal soil ● Lime ● Surkhi
(all units in kg)

Coloured mud block (%)



Normal mud block (%)

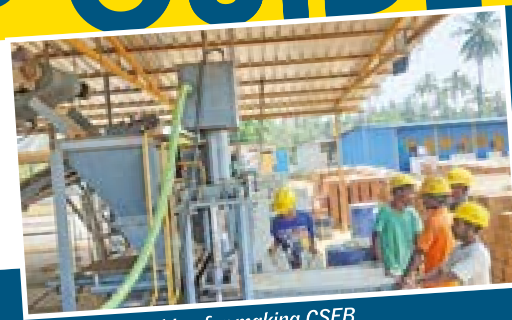


Malhar project, Bengaluru

For more information and to watch video **scan QR code**

STEP-BY-STEP GUIDE

COMPRESSED STABILIZED EARTHEN BLOCK USING AUTOMATED MACHINE



Motorized machine for making CSEB

Demonstration location: Bengaluru

Photo credits: Sugeet Grover / CSE

Material and equipment required

Soil, cement, water, sand, manual or motorized press

1 Soil, sand, cement, surkhi, lime and water are added in appropriate proportions into a mixing machine.

2 The machine mixes the ingredients thoroughly from where it is fed into the block-making machine.

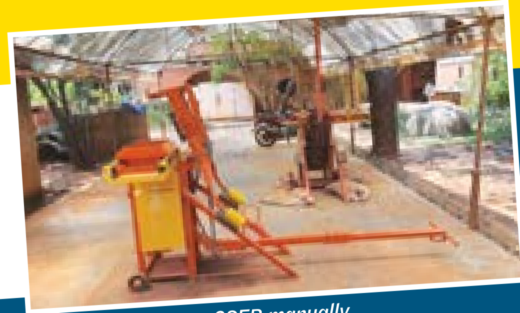
3 Two metallic plates are placed on the machine over which the mixture is poured and compressed by the machine.

4 The blocks come out after being compressed and a person picks up the metallic plate and the block together. Another person places two replacements plates in the machine.

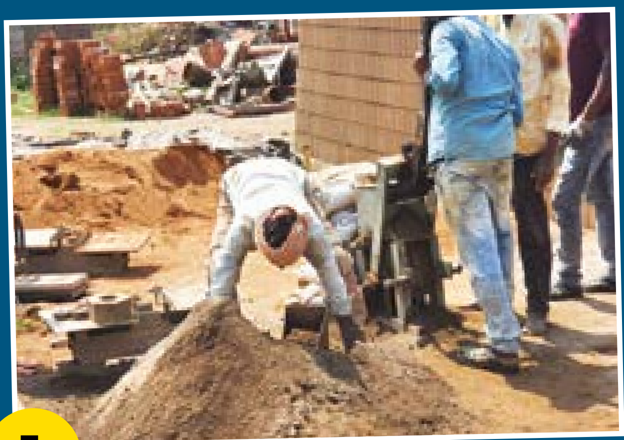
5 The person carrying the blocks places them to rest and brings the metallic plate back to the machine.

6 The blocks are kept for curing purposes and a person is assigned to put water onto the blocks.

COMPRESSED STABILIZED EARTHEN BLOCK USING MANUAL MACHINE



Machine for making CSEB manually



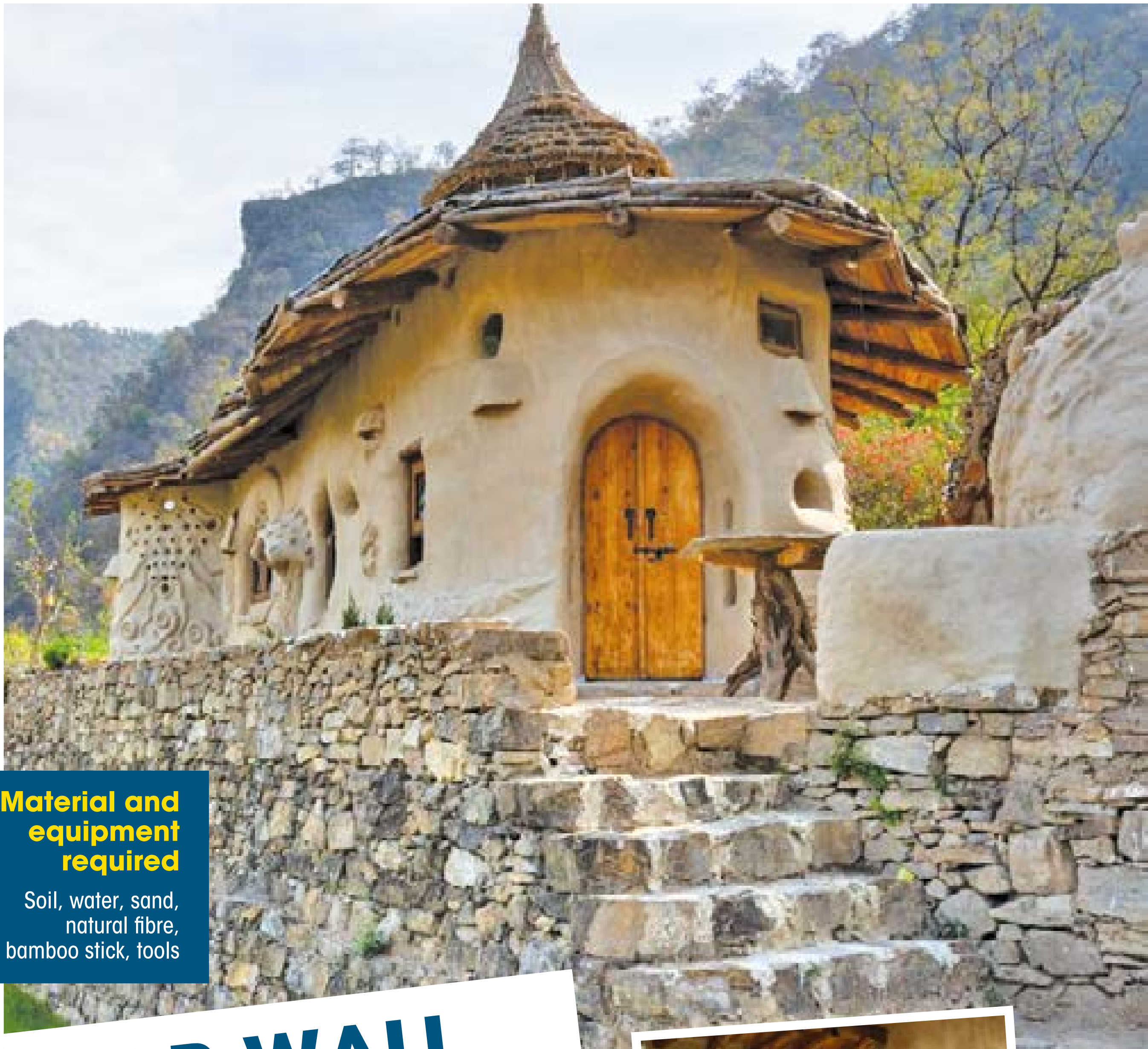
1 Soil, sand, cement, surkhi, lime and water are mixed manually in appropriate proportions.

2 The mixture is picked up and fed into the compressed earth block making machine manually.

3 It generally takes two masons to manually compress the mixture using the equipment.

4 Once compressed, the blocks come out of the machine from where masons pick them up and take them for curing.

Photo courtesy: thebetterindia.com



Material and equipment required

Soil, water, sand, natural fibre, bamboo stick, tools

COB WALL

This type of wall is structured with a mixture of soil (sand and clay), straw and, in some cases, lime. The clay component in the mortar imparts the binding property, the sandy part gives it strength, while the straw makes it less brittle by giving tensile strength. The straw also provides the wall with insulating properties. The proportions and composition of the mixture hence depend upon the type of soil used. The wet soil mixture is placed in horizontal courses and left to dry off before placing the next course on top of it.[1]

Photo courtesy: thebetterindia.com

Photo credit: Suget Grover / CSE

CHARACTERISTICS

- Since topsoil decomposes quickly and weakens the structural integrity of earth walls, it is not suitable for cob construction. Instead, the best soil for cob mixtures is just under topsoil.
- The soil mixture is often mixed with natural fibres such as thatch, coconut fibres etc. to increase its tensile strength.

WHERE CAN I LEARN MORE ABOUT THIS?

1. Apna Ghar construction system, Nagpur, Maharashtra
2. Jindal Ceramica: Offer training sessions to learn to build with thermobricks

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: thebetterindia.com

House of Bio-Materials, Rishikesh, Uttarakhand

1. House of Bio-Materials, Rishikesh, Uttarakhand (*see photograph*)
2. The Cob House, Badlapur, Thane, Maharashtra
3. Jod-Tod Qila, Nainital, Uttarakhand

SIMILAR TECHNIQUES

ADOBE BLOCK

TO LEARN MORE, see page 60

For more information and to watch video **scan QR code**

Sources:

1. Anumita Roychowdhury, Rajneesh Sareen, Mitashi Singh, Sugeet Grover and Harikrishnan CU 2022. *Wisdom to Build: A Compendium of Locally Evolved Materials and Techniques for Sustainable Self-built Housing,* Centre for Science and Environment, New Delhi.

STEP-BY-STEP GUIDE

COB WALL

Demonstration location:
Sacred Groves, Auroville, Tamil Nadu
Bolpur, West Bengal

1 Soil composition is tested using the sedimentation test. The three layers of soil—sand, silt and clay—are visible as layers; their proportions can be calculated by measuring heights.

2 Spread a tarp on the ground and add soil along with sand if needed, based on the required proportions. Sand should only be added if the soil contains too much clay.

3 Flip the tarp multiple times to thoroughly mix the materials. Pile up the dry mix and make a hollow or crater in the centre. It is safer to start with less water and add more if needed rather than using too much at once. Adding the correct amount of water comes with experience.[1]

4 At this stage, the mixture must go through a drop ball test. This is done by hand-rolling a ball of moistened subsoil (before adding straw) and dropping it from a height of 1 metre.

5 The lower half of the ball will flatten but the upper half should not lose its spherical shape. If there are cracks in the edges of the lower flattened side, the soil has more sand. If the upper dome shape deforms, the soil has more clay.

6 The mixture is also subjected to a crunch test done by making a ball of subsoil (moistened with water, but before adding straw) and pressing it in the palm. The amount of sand is then judged by the appearance of cracks. If there is excess of cracking, the sample has too much sand.[2]

7

Once the soil mix has passed the tests, add straw or other natural fibres to the mix. Longer fibres work well in the cob wall mix.

8

Soil and water are mixed thoroughly using foot work to make the mixture homogenous. If the mixture requires additional straw, sand or clay, the mason will add them at this step based on his judgement and experience of the mixture at hand.

9

To judge the tensile strength of the mixture, it is subjected to a cigar test. The cob is rolled into the shape of a cigar, held with a fist at either end and subjected to tensile force.

10

If it cannot be pulled apart into two pieces, the cob mix is made well.

11

Once the mixture is ready, a handful of the soil mixture is picked up.

12

The lump of mixed soil is taken and placed on top of the previous layer of soil. One might require a ladder for this step.

13

The lump of mixture is hand moulded to roughly fit the width of the wall.

14

A bamboo stick is used on sides of the wall to even out the surfaces and to bring the lump into shape.

15

The wall is then left to dry before another layer is applied.

Sources:

1. Sacred Groves Handbook

2. Ibid.

ADOBE BLOCK

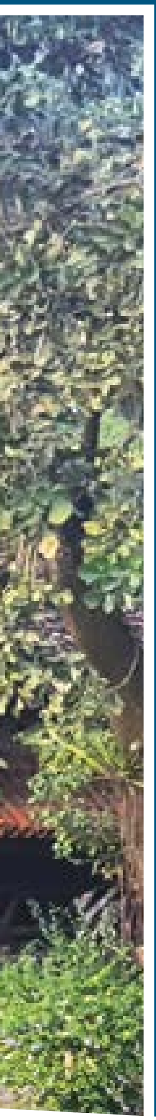
Adobe blocks are made up of materials such as clayey soil and straw and can be stabilized with either lime or cement. They are traditionally made in open-cast moulds and left to sun dry. They are laid using an earth mortar and smoothened with mud plaster as the wall finishes. These bricks are fire-resistant, flexible and durable, and provide sufficient thermal mass to ensure good energy efficiency and sound insulation.

Photo credit: Sugeet Grover / CSE

Material and equipment required

Clayey soil, straw, water, open cast moulds, cement or lime

Photo courtesy: Studio Shunya



CHARACTERISTICS

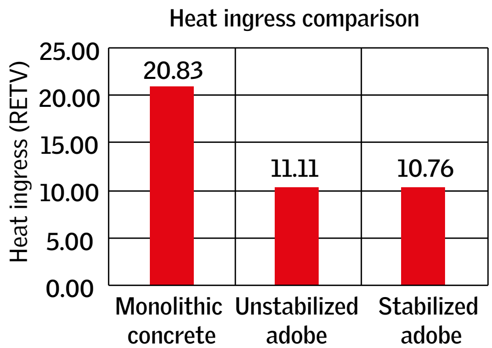
- An ideal adobe brick is made with a well-mixed combination of suitable soil containing coarse sand, fine sand, silt and clay (with the clay content in the range of 15–20 per cent)[1] as well as fibrous plant material.
- Thermal performance: The heat ingress analysis revealed that a house with 230-mm-thick stabilized adobe brick walls had ~47 per cent lower heat ingress while 230-m unstabilized adobe brick walls had ~48 per cent lower heat ingress when compared to a house with 150-mm-thick monolithic concrete walls.
- Thermal performance: The heat ingress analysis revealed that a house with 230-mm-thick CSEB walls had ~46 per cent lower heat ingress while 230-mm unstabilized CEB walls had ~50 per cent lower heat ingress when compared to a house with 150-mm-thick monolithic concrete walls.

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

The Mud House, Bolpur, West Bengal

1. Studio Shunya Experience Home Office, Greater Noida, Delhi-NCR
2. The Mud House, Bolpur, West Bengal (*see photograph*)

Graph 6: Comparison of heat ingress: monolithic concrete and adobe blocks



WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
2. Geeli Meeti Farms, Nainital, Uttarakhand
3. Sacred Groves, Auroville, Tamil Nadu
4. NIRD&PR, Hyderabad
5. Sacred Groves, Auroville, Tamil Nadu
6. Mrinmayee Consultants, Bengaluru, Karnataka
7. Sankalan-Hunnarshala, Bhuj, Gujarat
8. Anangpur Building Centre, Haryana
9. Thannal Natural Homes, Tiruvannamalai, Tamil Nadu
10. Himalayan Institute of Alternatives, Ladakh, Leh, Ladakh
11. Geeli Mitti, Pangot (near Nainital), Uttarakhand
12. Studio Shunya, Greater Noida, UP
13. The North, Naggar, Himachal Pradesh
14. Matikaam, Vadodara, Gujarat
15. Habitat Technology Group, Thiruvananthapuram, Kerala
16. Project Potential, eArthshala, Bihar

SIMILAR TECHNIQUES

COB WALL

TO LEARN MORE, see page 56

Source: How to Make Adobe Bricks, https://dharmalaya.in/articles/natural-building/how-to-make-adobe-bricks

STEP-BY-STEP GUIDE

ADOBE BLOCKS

Demonstration location: Sacred Groves, Auroville, Tamil Nadu,
Photo credits: Sugeet Grover

1

Begin by excavating soil from the site if it is suitable for construction. Using on-site soil reduces energy, time and overall construction costs. The ideal soil for rammed earth should be sandy or gravelly rather than clayey.

2

A mixture of soil and sand is prepared. The exact proportion of sand that is added is dependent on the original soil composition. This dry mixture is mixed.

3

A crater is made in the middle of the dry mix. Water is poured into the crater. A gap of about 15 minutes is given for the dry lumps of soil absorb water. That way they crumble easily and there will be no dry soil in the mix.

4

Initially mixing is done by hand and then with the feet to break the last stubborn lumps. Water is gradually added as and when required to achieve a good consistency.

5

Natural fibres like rice straw, rice husk straw, coconut husk etc. are used. Shorter-length fibres are more suitable for adobe blocks.

6

The mixture is mixed thoroughly using foot work to make it homogenous.

7

The mould is dampened with water before pouring the mix to prevent it from sticking. Its inner surfaces should be smooth to ensure easy release of the mix. Sand is poured on the base of the mould so that the brick does not stick to the base.

8

The mix is placed into the mould and pressed using fingers to remove air gaps. Once filled, the top surface should be levelled. The process should be done quickly, as the mix can start drying and stick to the mould's inner surface.

10

The bricks are left to dry in the shade until they can be lifted without spoiling the shape. They are then placed vertically (for faster drying) and dried under the sun for a minimum of two days or until all the moisture is lost.[1]

9

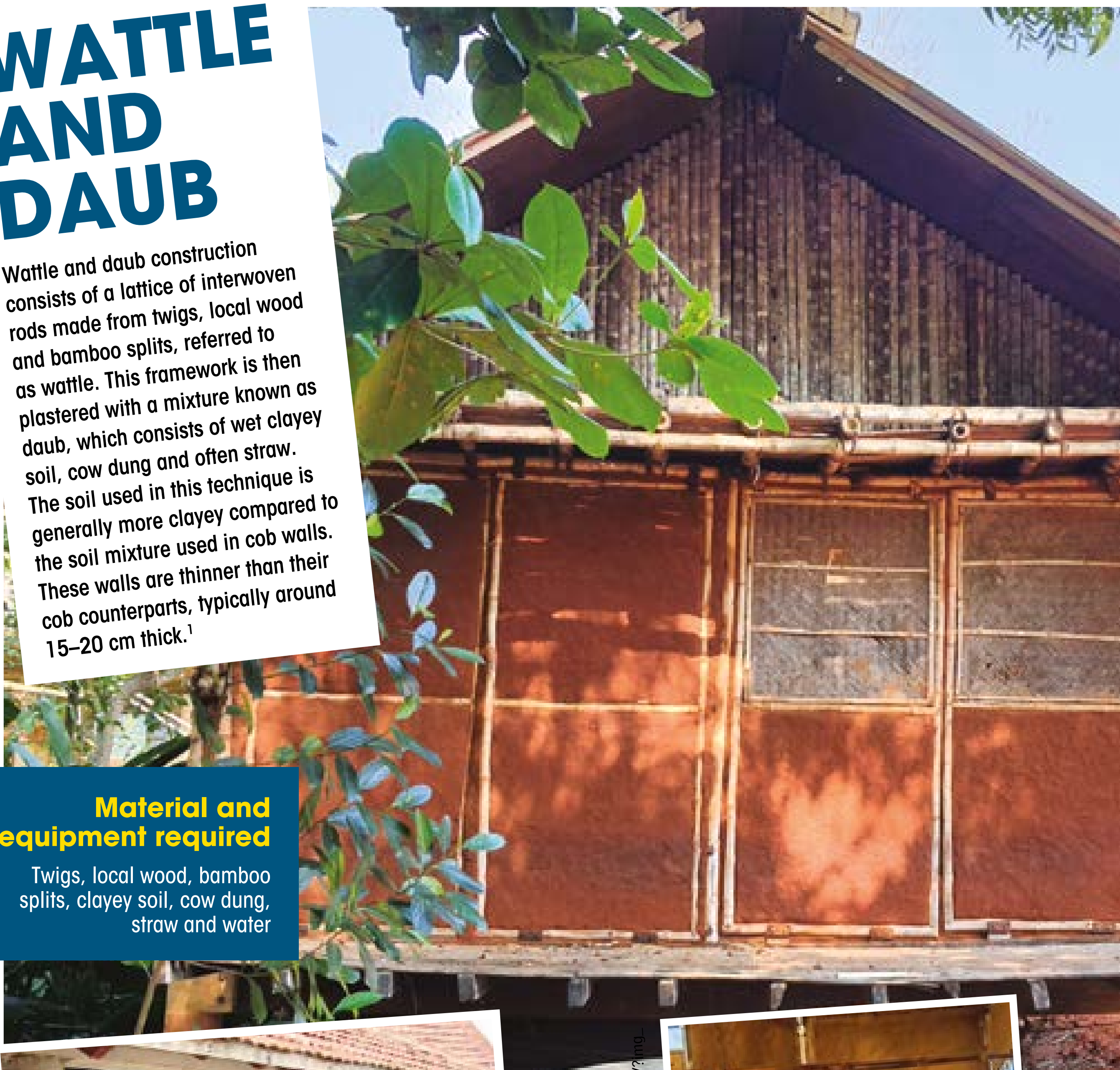
The mould is lifted carefully to keep the shape of the brick intact.

Source:

1. Sacred Groves Handbook

WATTLE AND DAUB

Wattle and daub construction consists of a lattice of interwoven rods made from twigs, local wood and bamboo splits, referred to as wattle. This framework is then plastered with a mixture known as daub, which consists of wet clayey soil, cow dung and often straw. The soil used in this technique is generally more clayey compared to the soil mixture used in cob walls. These walls are thinner than their cob counterparts, typically around 15–20 cm thick.[1]



Material and equipment required

Twigs, local wood, bamboo splits, clayey soil, cow dung, straw and water

Photo courtesy: materialinks.wordpress.com

Photo courtesy: https://www.instagram.com/p/Cq9XyDvyiKy/?img_index=5&igsh=b2RhbHVxdzMxNXlh

CHARACTERISTICS

- Various kinds of soil may be used for wattle and daub but different soil types will require different additions.
- Clayey and silty-clay soils, when stabilized with sand or natural fibres, are well-suited for wattle and daub construction, while sandy-clay soil requires stabilization with natural fibres to achieve similar suitability.[2]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Thannal Natural Homes, Tiruvannamalai, Tamil Nadu
2. Sankalan-Hunnarshala, Bhuj, Gujarat
3. Rural Building Centre, National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad
4. Auroville Earth Institute, Auroville, Tamil Nadu
5. Sacred Groves, Auroville, Tamil Nadu
6. Geeli Meeti Farms, Nainital, Uttarakhand
7. Himalayan Institute of Alternatives Ladakh, Leh, Ladakh
8. Geeli Mitti, Pangot (near Nainital), Uttarakhand
9. North, Naggar, Himachal Pradesh
10. Matikaam, Vadodara, Gujarat
11. Project Potential, eArthshala, Bihar

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: thannal.com

Wattle and daub cottage, Sukrushi Organic Farm, Nelamangala, Bengaluru, Karnataka

1. **Wattle and Daub Cottage, Sukrushi Organic Farm, Nelamangala, Bengaluru, Karnataka (*see photograph*)**
2. **Good Karma Farmhouse, Alibaug, Maharashtra**
3. **Khamir Craft Resource Centre, Bhuj, Gujarat**
4. **Thannal Natural Homes, Tiruvannamalai, Tamil Nadu**
5. **Rural Building Centre, The National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad**

SIMILAR TECHNIQUES

COB WALL

TO LEARN MORE, see page 56

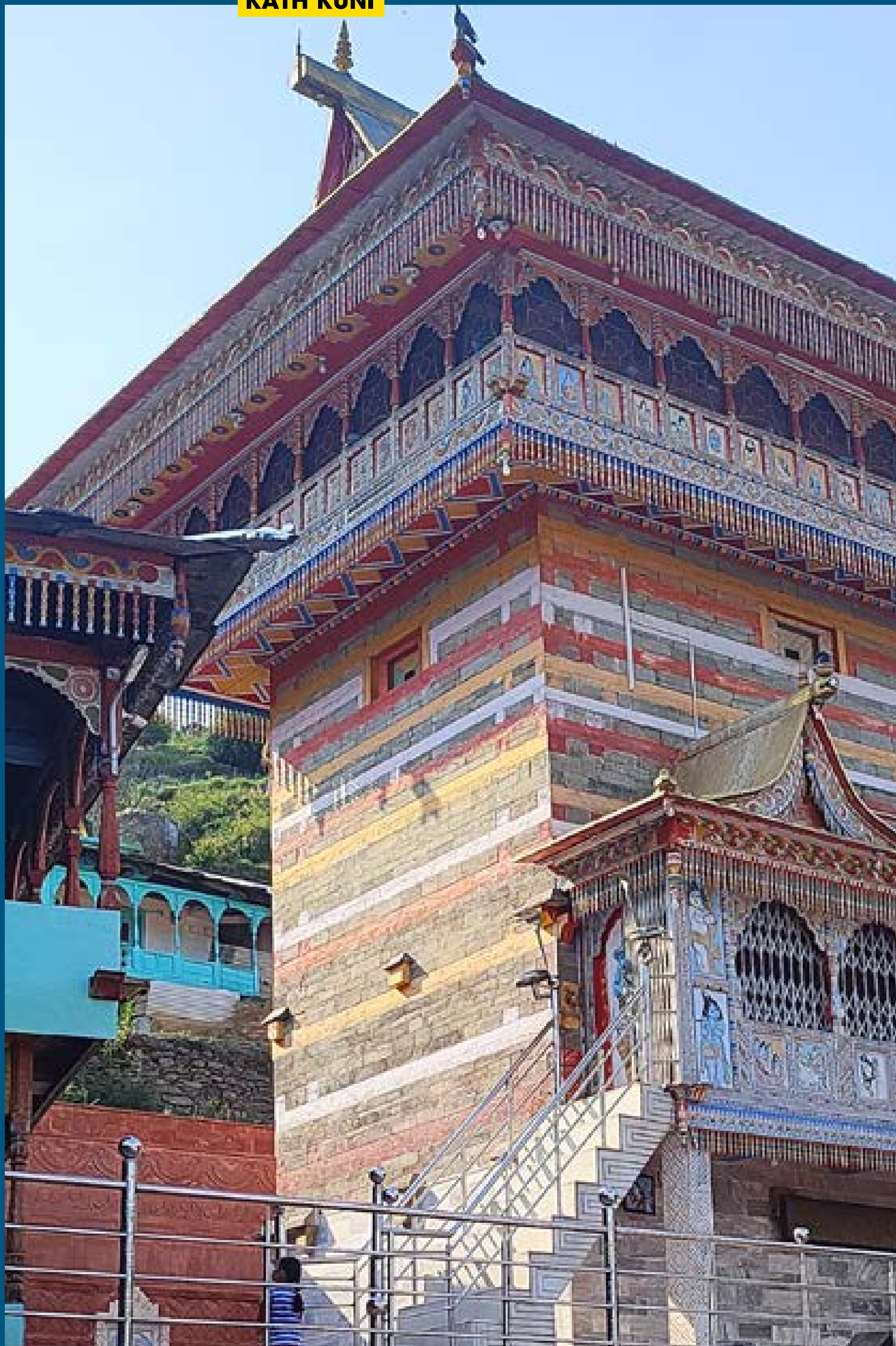
Sources:

Anumita Roychowdhury, Rajneesh Sareen, Mitashi Singh, Sugeet Grover and Harikrishnan CU 2022. *Wisdom to Build: A Compendium of Locally Evolved Materials and Techniques for Sustainable Self-built Housing*, Centre for Science and Environment, New Delhi

2. Auroville Earth Institute, https://dev.earth-auroville.com/raw-materials/, last accessed in July 2025

WOOD- AND STONE-BASED CONSTRUCTION

KATH KUNI



DHAJJI DIWARI

Photo courtesy: thenorth.in

ASHLAR MASONRY

RANDOM RUBBLE

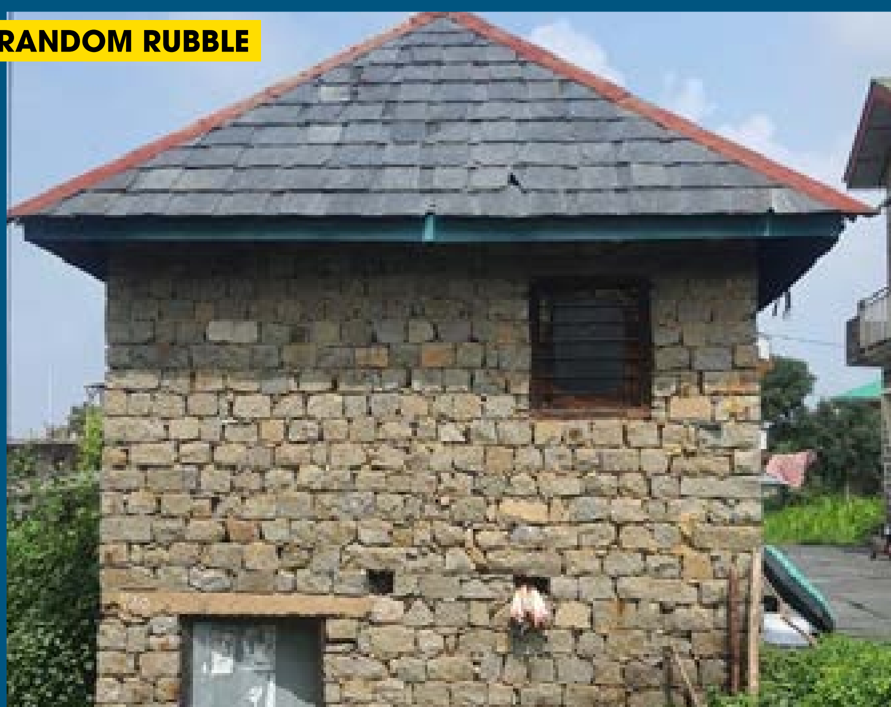
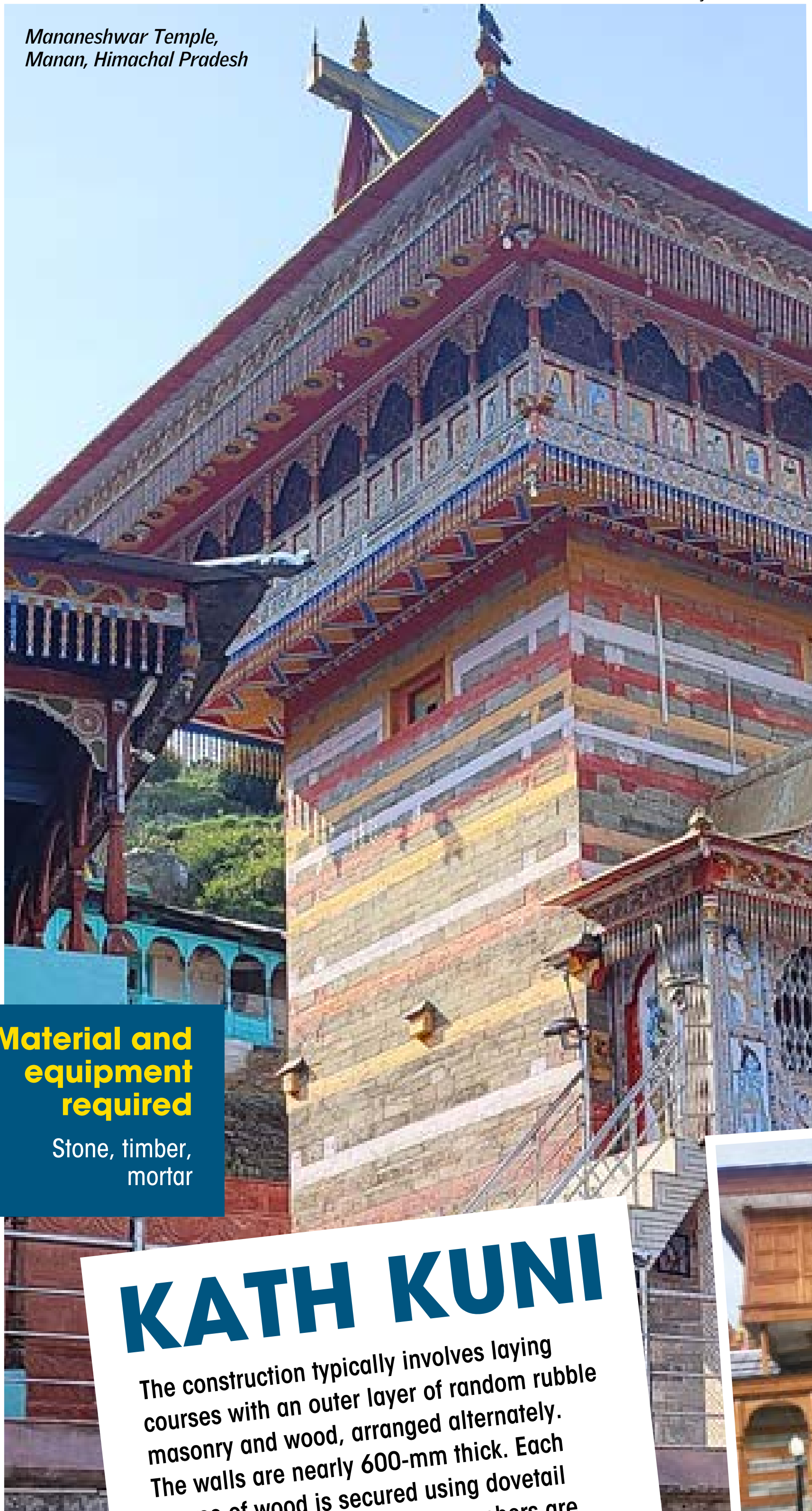


Photo credit: Rajneesh Sareen



Mananeshwar Temple, Manan, Himachal Pradesh

Source: architecturaldigest.in

Material and equipment required

Stone, timber, mortar

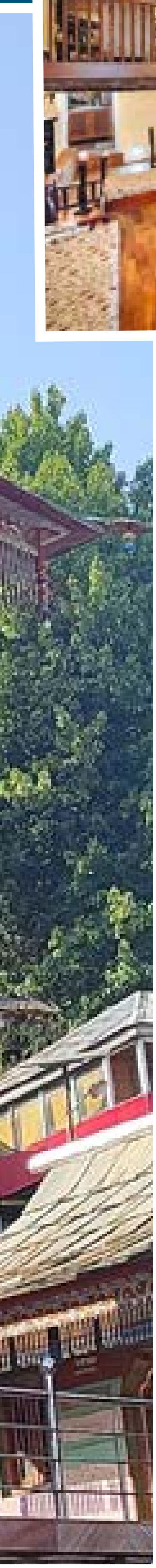
KATH KUNI

The construction typically involves laying courses with an outer layer of random rubble masonry and wood, arranged alternately. The walls are nearly 600-mm thick. Each course of wood is secured using dovetail joints, ensuring the wooden members are held firmly in place. The courses continue to alternate until the ceiling height is reached, with the cavity between the layers of wood and stone filled with smaller stones.[1]

Bhimakali Temple, Sarahan, Himachal Pradesh

Photo credit: Rajneesh Sareen / CSE

Source: architecturaldigest.in



CHARACTERISTICS

• Kath kuni construction is a traditional building technique from the Himalayan region that uses locally available wood and stone in an interlocking, layered pattern. The term comes from local words *kath* (meaning wood) and *kuni* (meaning corner), reflecting its distinctive style where wooden beams are placed at the corners of stone walls.[2]

• Kath kuni buildings are easily recognized by their distinctive layered interlocking of wood and stone, topped with slate roofs. The use of a limited set of materials has given rise to a unique aesthetic, with hard and soft elements, warm and cool tones, and rough and smooth textures balanced.[3]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Himalayan Brothers Trust for Art and Cultural Heritage (HBTACH), Naggar, Himachal Pradesh
2. National Crafts Museum
3. North, Naggar, Himachal Pradesh

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: wikimedia.org

The Naggar Castle, Himachal Pradesh

1. **Apple Farm Stay, Himachal Pradesh**
2. **The Naggar Castle, Himachal Pradesh (*see photograph*)**
3. **The Bhimakali Temple Complex, Sarahan, Himachal Pradesh**
4. **Chehni Kothi, Banjar, Himachal Pradesh**

For more information and to watch video **scan QR code**

SIMILAR TECHNIQUES

DHAJJI DIWARI

TO LEARN MORE, see page 70

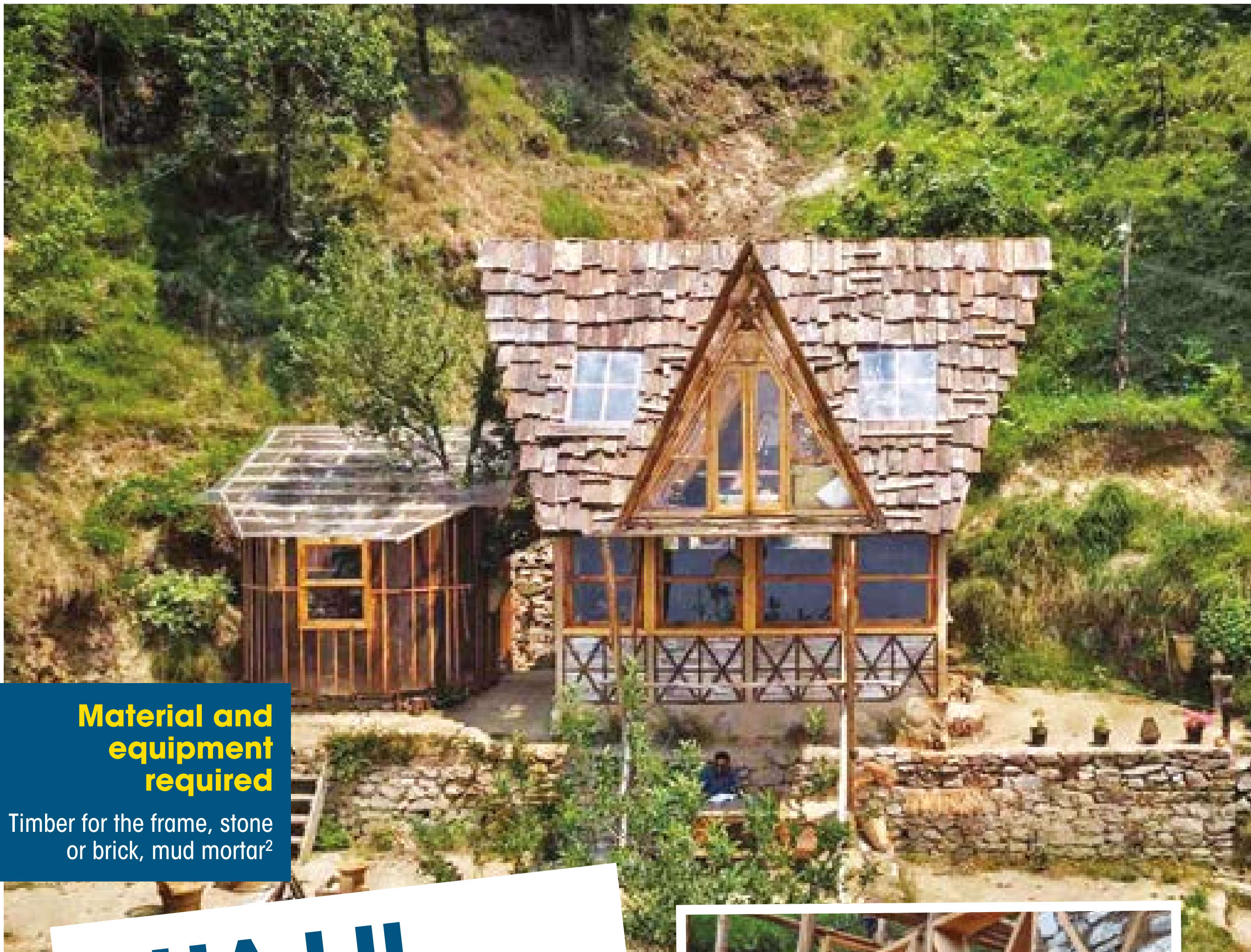
Sources:

1. Anon. 2021. *Compendium of Building Technologies*, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. https://www.sahapedia.org/the-himalayan-vernacular-kath-khuni-architecture

3. Ibid.

Source: thenorth.in

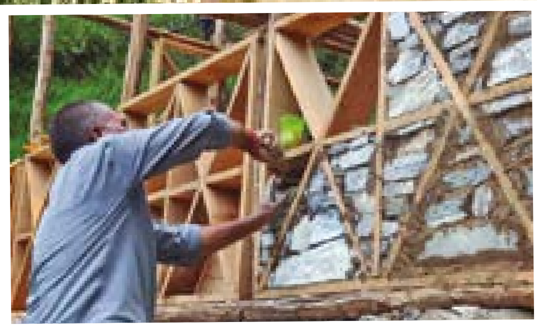


Material and equipment required

Timber for the frame, stone or brick, mud mortar[2]

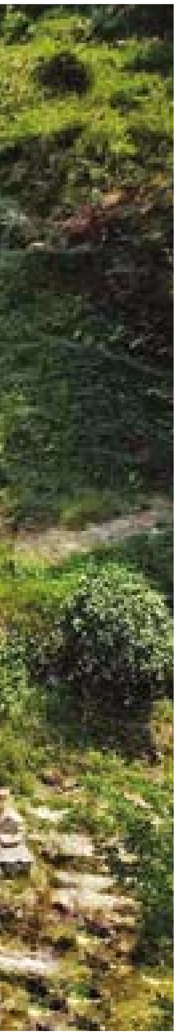
DHAJJI DIWARI

Dhajji diwari is a type of traditional building found in the western Himalayas using local materials such as timber and masonry infill. Dhajji construction typically features a braced timber frame filled with a single layer (wythe) of stone or brick masonry, traditionally set in mud mortar and finished with mud plaster. These buildings usually rest on shallow stone masonry foundations. Dhajji structures are generally one to four storeys tall, with roofs that may be flat timber and mud or pitched with timber or metal sheeting.[1]



Source: https://aim2flourish.com

Source: https://a0.muscache.com



CHARACTERISTICS

• Dhajji dewari uses a flexible timber frame designed to absorb seismic energy during earthquakes. The infill masonry, typically made of stone or brick, is held within the wooden frame, enabling the entire structure to sway smoothly without cracking or collapsing. This distinctive combination makes dhajji dewari a highly effective solution for earthquake resistance.

• Dhajji diwari construction is only feasible in regions with abundant timber as it relies on a timber frame infilled with masonry for structural integrity.[3] This form of construction is also referred to in the Indian Standard Codes as brick nogged timber frame construction.[4]

• Thermal performance: During winter, dhajji diwari structures have been found to retain 25–30 per cent more heat than contemporary buildings made with fired clay bricks and cement mortar as per a study. The study also found indoor temperature to be higher by 2°C on average.[5]

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: thenorth.in

The Dhajji Cabin, Himachal Pradesh

1. **The Dhajji Cabin, Himachal Pradesh**

WHERE CAN I LEARN MORE ABOUT THIS?

1. Himalayan Brothers Trust for Art and Cultural Heritage (HBTACH)
2. North, Naggar, Himachal Pradesh

SIMILAR TECHNIQUES

KATH KUNI

TO LEARN MORE, see page 68

Sources:

1. Anon. 2021. *Compendium of Building Technologies*, Central Building Research Institute and Building Materials and Technology Promotion Council.
2. Ibid.
3. Ibid.
4. Anon. 2012, World Housing Encyclopedia, https://www.world-housing.net/asia/india/report-146-dhajji-dewari, last accessed in July 2025
5. Bhat, Tahir Mohammad and Buch, Shujaat Hussain and Banka, Asif Ali, 2025, *Comparison of Thermal Performance of Traditional and Contemporary Masonry Structures in Himalayan Region*. Available at SSRN: https://ssrn.com/abstract=5175172, last accessed in July 2025.

Photograph Courtesy: Rajneesh Sareen

Material and equipment required

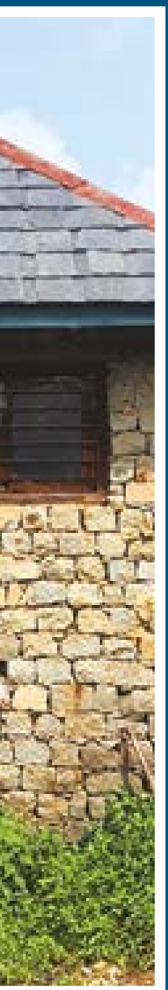
Rough, irregularly shaped stones, cement, sand, water

RANDOM RUBBLE

Irregular-sized and shaped stones are used to create this type of wall. They are stacked on top of one another, with mud and cement or lime mortar acting as binding materials. Types of stone commonly used in building construction are granite, trap, basalt, quartzite, limestone and sandstone. Locally available softer varieties of stone such as laterite are also used in low-rise houses.[1]

Random rubble masonry can be of various types but there are two broad ones: uncoursed random rubble masonry, where stones are laid without any attempt to align them in horizontal layers, and coursed random rubble masonry, where stones are roughly dressed and laid in more or less level courses for a neater finish. There are many variations among these—a dry rubble version also exists wherein the stones are placed without the help of mortar. The stones in such a scenario rely on their interlocking shapes and weight for stability.

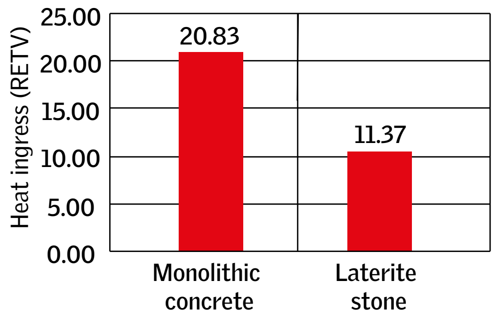
Photo credit: Sugeet Grover / CSE



CHARACTERISTICS

- Thermal performance: The thermal performance of a random rubble stone wall will be completely dependent on the kind of stone and its thickness used. Laterite stone is one stone that maybe used, the heat ingress analysis revealed that a house with 205-mm-thick laterite stone walls had ~45.5 per cent lower heat ingress compared to 150-mm-thick monolithic concrete walls

Graph 7: Comparison of heat ingress: monolithic concrete and laterite blocks



BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Agrasen ki Baoli, Delhi

1. Agrasen ki Baoli, Delhi (*see photograph*)
2. Golconda Fort, Hyderabad
3. Chittorgarh Fort, Rajasthan
4. Rural Building Centre, The National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad

WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
2. Geeli Mitti, Pangot (near Nainital), Uttarakhand
3. Nirmithi Kendra, Karnataka

SIMILAR TECHNIQUES

ASHLAR MASONRY

TO LEARN MORE, see page 76

Source:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council

STEP-BY-STEP GUIDE

RANDOM RUBBLE MASONRY

Demonstration location: Odisha
Photo credits: Harikrishnan CU

1 Different stone sizes are used in wall construction. Larger rocks are collected and broken down into smaller easier-to-handle pieces.

2 Mud mortar is prepared by mixing clayey and coarse soil with water.

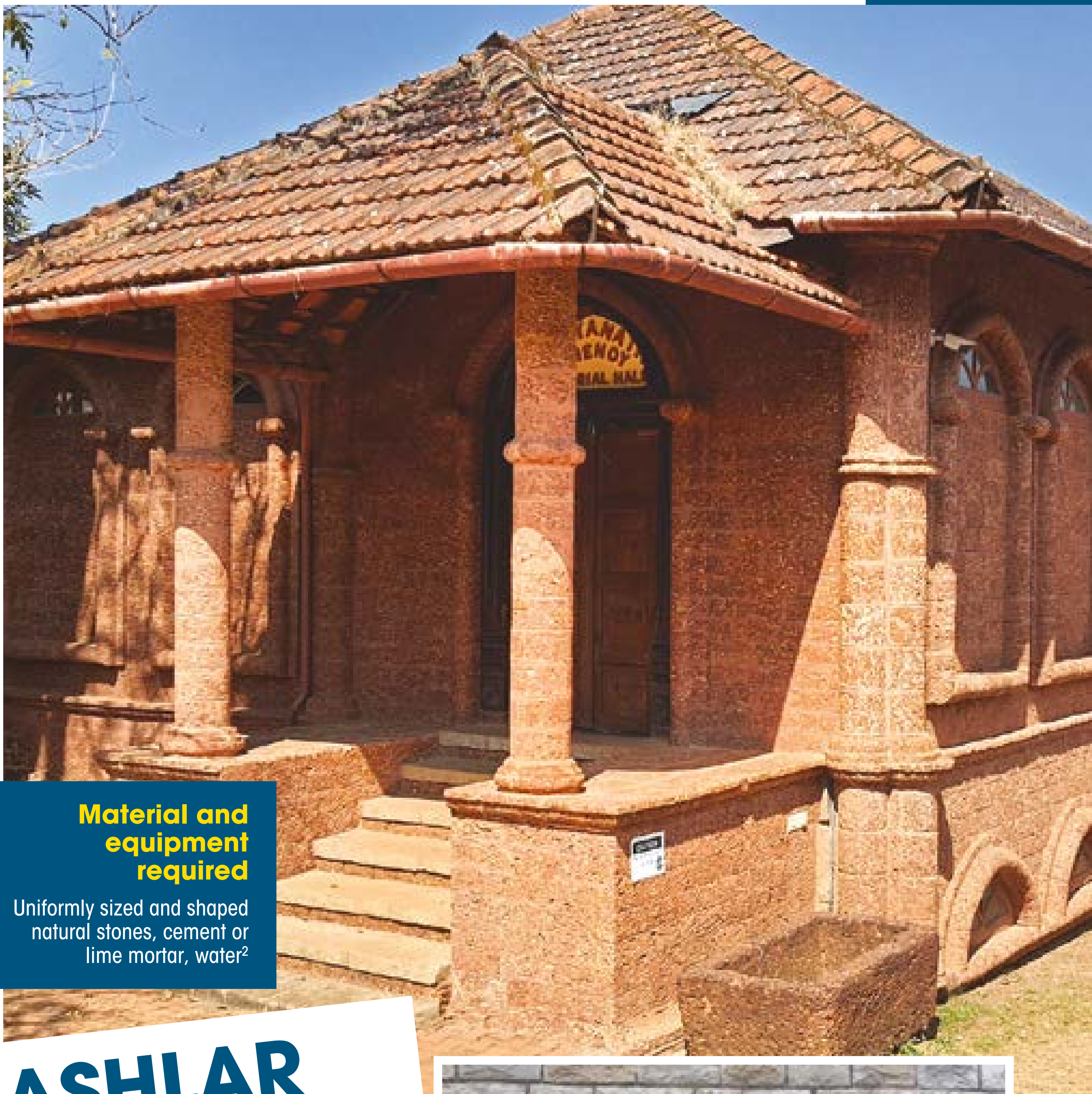
3

For constructing the walls of the house, random rubble stones are laid layer by layer by using mud mortar as a binding material.

4

During the construction phase, timber or bamboo-based support structures are provided for placing a roofing framework as well as lintels for door and window frames.

Photo credit: Sugeet Grover / CSE



Material and equipment required

Uniformly sized and shaped natural stones, cement or lime mortar, water[2]

ASHLAR MASONRY

Ashlar masonry is a type of stone masonry which is formed using dressed stones of same size, shape and texture laid together in cement or lime mortar of equal-sized joints at right angles to each other and in level courses. It is considered best suitable for load-bearing walls.[1]

Photo credit: Sugeet Grover / CSE

Source: *Building Wise*, CSE

CHARACTERISTICS

- For ashlar masonry work, it is specified that the length should not exceed three times the height. The breadth should not be greater than three-fourths of the thickness of the wall or less than 150 mm. The height can be up to 300 mm.
- The stones should not be larger than what can be handled and placed by one person.[3]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

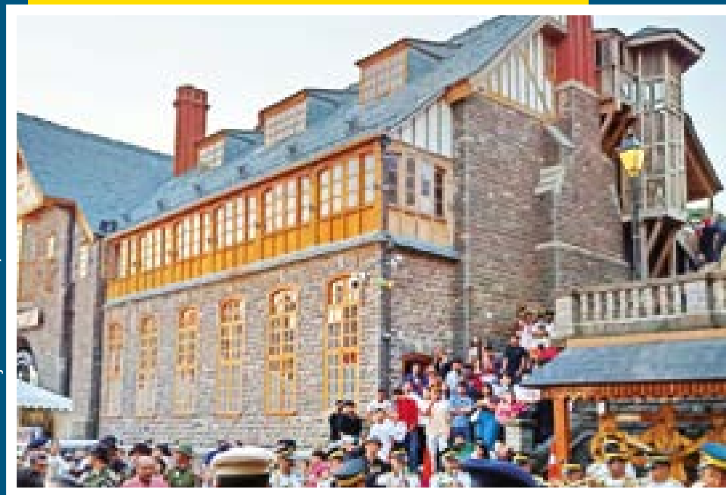


Photo credit: Rajneesh Sareen / CSE

Town Hall, Mall Road, Shimla, Himachal Pradesh

1. Town Hall, Mall Road, Shimla, Himachal Pradesh (*see photograph*)
2. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
3. Hasta Shilpa Heritage Village Museum, Manipal, Karnataka

SIMILAR TECHNIQUES

RANDOM RUBBLE MASONRY

TO LEARN MORE, see page 72

For more information and to watch video **scan QR code**

Sources:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

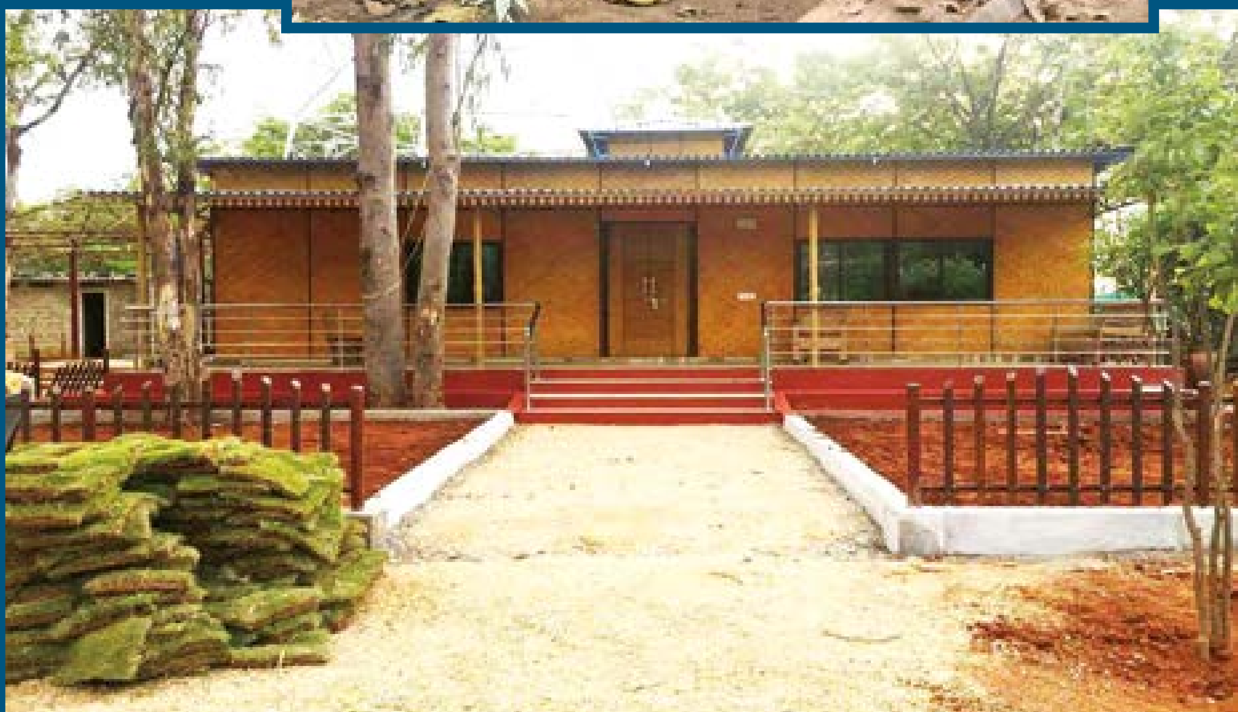
3. Ibid.

BAMBOO-BASED WALLING

BAMBOO STRIP WALLING

BAMBOO STRIP WALLING

MAT WALL PANELS



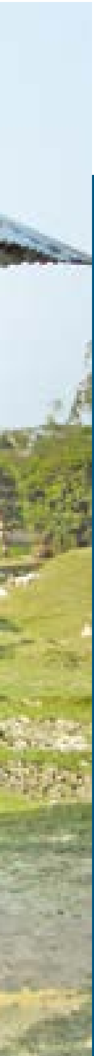
Material and equipment required

Bamboo strips, bamboo, wire mesh

BAMBOO STRIP WALLING

Source: *Building Wise*, CSE

Bamboo strip walling is a simple building method where walls are made by weaving or arranging thin strips of bamboo in a crisscross pattern. These strips are tied together using wire to form strong panels. These panels are then fixed between the wooden or bamboo frame of a building—like between the columns and beams. Although the walls don't carry the weight of the building (they're non-load bearing), they provide privacy and help keep the structure stable, especially during strong winds or earthquakes.[1] Another variation exists where instead of a mud plaster, cement is used, commonly referred to as bamboo-crete.



Source: *Compendium of Building Technologies*, Central Building Research Institute and Building Materials and Technology Promotion Council

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Source: *Building Wise*, CSE

Kosi flood victim housing by Hunnarshala

Photo credit: Sugeet Grover / CSE

Sources:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

SIMILAR TECHNIQUES

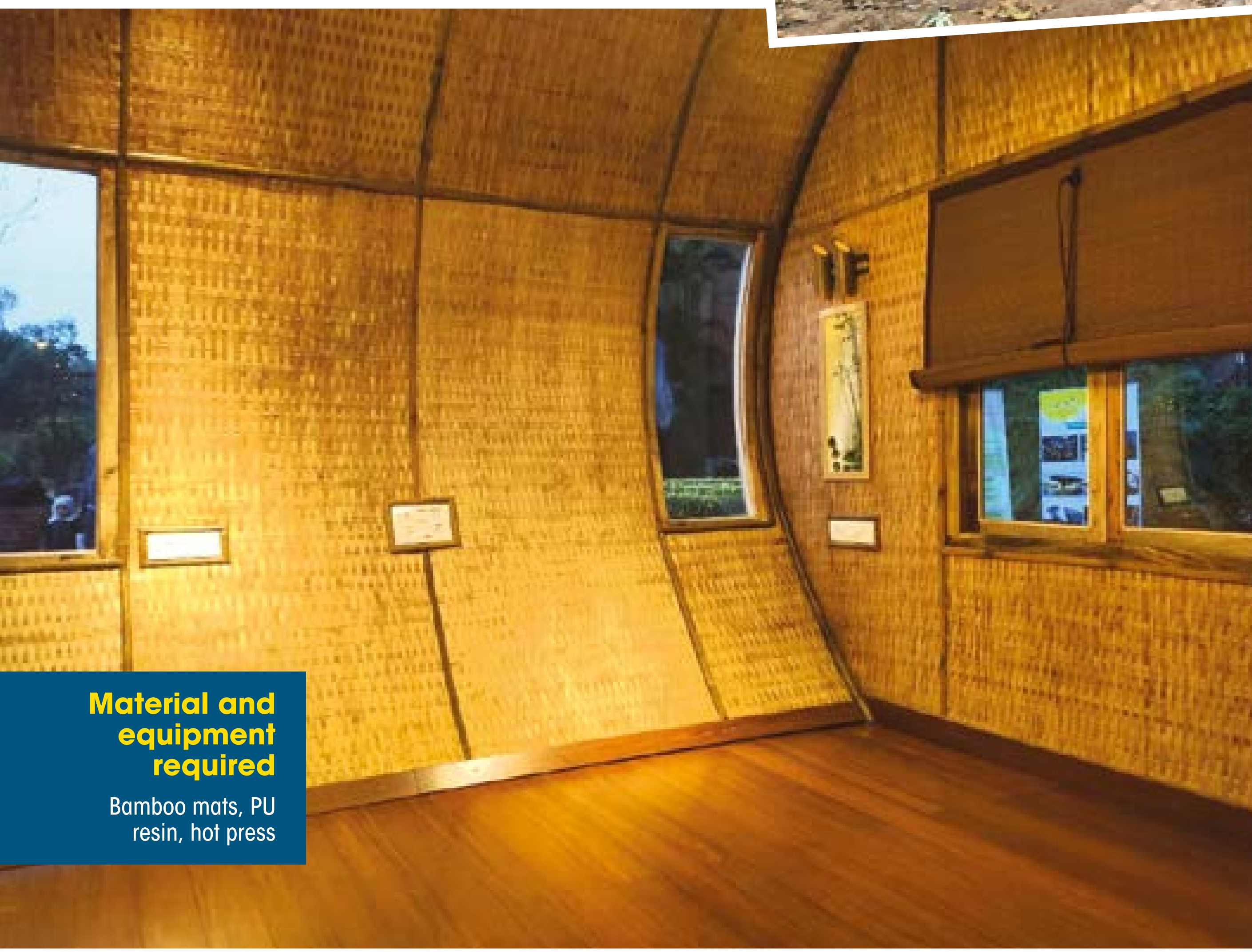
BAMBOO PANEL

TO LEARN MORE, see page 82

BAMBOO MAT WALL PANELS

Bamboo mat board is made out of multilayer bamboo mats soaked in PU resin and pressed in a hot press. The manufacturing process involves application of specially formulated phenol formaldehyde (PF) resin to the mats, assembling the resin-coated mats and hot pressing in hydraulic press at specified temperature and pressure. These wall panels can be used as infill wall panel with structural frame of RCC or steel, false ceiling, partitions, walling, wall panelling, etc. These products are certified as per IS relevant codes.[1]

Photo credit: Sugeet Grover



Material and equipment required

Bamboo mats, PU resin, hot press

Source: https://bamboosocietyofindia.com/venu-kutir

Source: https://timpackgreengold.com/

WHERE CAN I LEARN MORE ABOUT THIS?

1. Timpack Green Gold, Meghalaya
2. Bamboo House India, Hyderabad, Telangana

Source: *Building Wise*, CSE

SIMILAR TECHNIQUES

BAMBOO STRIP WALLING

TO LEARN MORE, see page 80

Sources:

1. Anon. 2021. Compendium of Indigenous Innovative Building Materials and Construction Technologies, Ministry of Housing and Urban Affairs, Government of India, New Delhi

2. Ibid.

BLOCKS FROM RECYCLED AGRICULTURE WASTE

AGROCRETE BLOCKS A

AND HEMPCRETE BLOCKS

BIO-BRICKS

BIO-BRICKS

Photo courtesy: greenjams.org

Material and equipment required

Agrocrete blocks, bio-bricks, hemp-crete blocks, mortar, chopped straw, lime powder, water[3]

AGROCRETE, BIO-BRICKS AND HEMP-CRETE BLOCKS

A number of construction blocks have emerged in the market that utilize biomass or crop residues such as paddy straw, cotton stalk, bagasse, hemp etc. These solid blocks are lightweight and often have better insulation properties than conventional bricks.

One of these products is agrocrete blocks, which are load bearing and can support structures up to G+1 or be used in partition walls in multistorey buildings.[1]

In the case of bio-bricks developed by IIT Hyderabad, agro-waste such as paddy straw, wheat straw, sugarcane bagasse and cotton plant is chopped to the desired size and mixed by hand or mixer with a lime-based slurry and water. To make compact bricks, the mixture is poured into moulds and thoroughly compacted with a wooden dowel.[2]

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

A guard cabin based on bio-bricks is constructed in IIT Hyderabad

1. **Ajmera Greenfinity, Wadala, Mumbai**
2. **A guard cabin based on bio-bricks is constructed in IIT Hyderabad**

CHARACTERISTICS

- Agrocrete blocks are an efficient alternative to autoclaved aerated concrete blocks and hollow burnt-clay blocks, as they provide 40 per cent higher thermal insulation and reduce construction cost by 40 per cent.[4]
- Bio-bricks offer effective thermal insulation when used in roofing and wall panelling, helping to reduce indoor heat gain by 5–6°C.[5]
- Chopped husk and lime slurry are mixed in a 1:3 ratio by weight, with traditional additives such as bel fruit pulp, river clay slurry and liquid molasses incorporated to enhance strength and binding in the bio-brick.[6]

Source: thebetterindia.com

Sources:

1. Anon. 2021. Compendium of Indigenous Innovative Building Materials and Construction Technologies, Ministry of Housing and Urban Affairs, Government of India, New Delhi

2. Ibid.

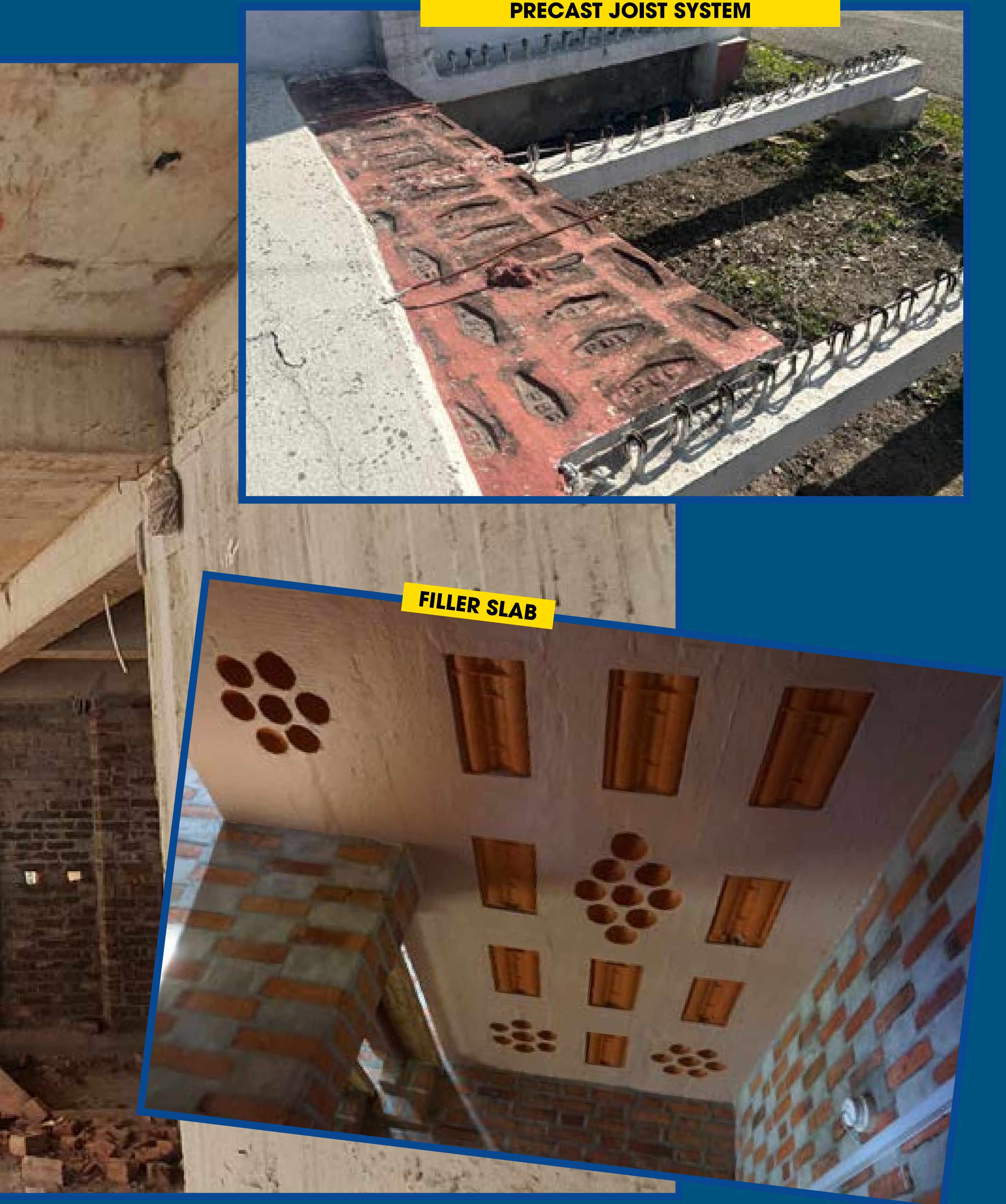
3. Ibid.

4. Confederation of Indian industry, https://cleanairlibrary.in/case_study/agrocrete-paddy-straw-bricks/#:~:text=Agrocrete%20comes%20under%20two%20versions,%2C%2020%25%20thinner%20walls, last accessed in July 2025.

5. IIT Hyderabad, https://www.youtube.com/watch?v=iOFOUXrmw_w, last accessed in July 2025.

6. Anon. 2021. Compendium of Indigenous Innovative Building Materials and Construction Technologies, Ministry of Housing and Urban Affairs, Government of India, New Delhi

FLAT ROOFS AND INTERMEDIATE FLOORS



PRECAST BRICK PANEL AND PARTIALLY PRECAST JOIST SYSTEM

FILLER SLAB

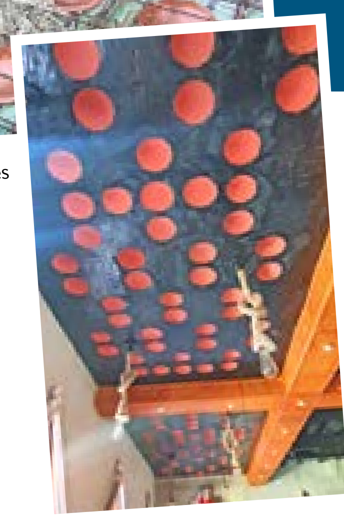
Material and equipment required

Concrete, steel rods, shuttering, bar cutting tools, plate and needle vibrator, filler material such as pots, bricks, shuttering[2]

FILLER SLAB

In this technology, the concrete in the tension zone is partially replaced with lightweight and low-cost filler material. The placement of the filler materials ensures that structural strength, stability and durability are not compromised, resulting in the replacement of non-functioning concrete. Low-grade Mangalore tiles, Thermopolis burnt clay bricks, hollow concrete blocks, stabilized mud blocks/hollow mud blocks, inverted clay pots, coconut shells, AAC blocks and other lightweight, inert and inexpensive materials can be used as filler materials. These materials are laid in the grids of steel reinforcement and concrete topping is done over them.[1]

Source: https://ongrid.design/blogs/sustainable/filler-slab-design-for-homes



CHARACTERISTICS

• Cost-effective, lightweight and non-reactive materials like low-grade tiles, clay bricks, hollow concrete or mud blocks, stabilized mud blocks, clay pots, coconut shells, and AAC blocks can serve as filler materials.

• This method can reduce overall construction costs by 15–20 per cent, with savings of around 19 per cent in cement and 38 per cent in steel compared to a traditional RCC slab.

• Using this approach can lower total embodied energy by approximately 15 per cent in comparison to a solid RCC slab.

• Filler slabs can be aesthetically left exposed (if executed with care), offering a visually appealing ceiling and eliminating the need for plaster or paint.

• Approx. 25–30 per cent conventional savings in cost as compared to reinforced concrete slab.

WHERE CAN I LEARN MORE ABOUT THIS?

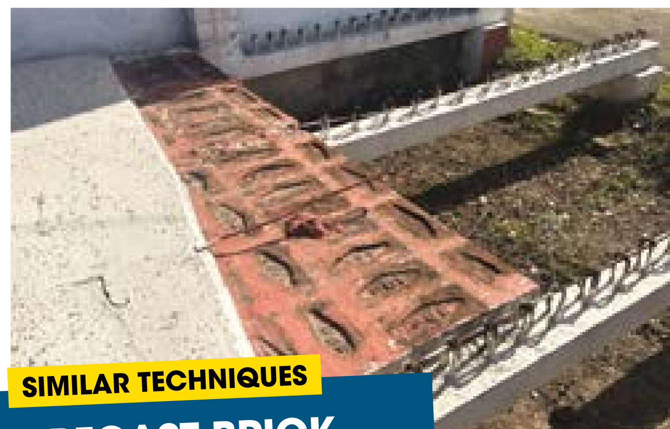
1. Habitat Technology Group, Thiruvananthapuram, Kerala
2. Karnataka Rajya Nirmana Kendra, Bangalore, Karnataka
3. Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala
4. Rural Building Centre, The National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad
5. Kerala State Nirmithi Kendra, across Kerala
6. Nirmithi Kendra, Karnataka

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo creidt: Sugeet Grover / CSE

Centre for Development Studies, Thiruvananthapuram, Kerala

1. Gyaan Centre, Jaisalmer, Rajasthan
2. Centre for Development Studies, Thiruvananthapuram (*see photograph*)
3. Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala
4. Alma Mater School, Jodhpur



SIMILAR TECHNIQUES

PRECAST BRICK PANEL

TO LEARN MORE, see page 92

Sources:

1. Anumita Roychowdhury, Rajneesh Sareen, Mitashi Singh, Sugeet Grover and Harikrishnan CU 2022. Wisdom to Build: A compendium of locally evolved materials and techniques for sustainable self-built housing, Centre for Science and Environment, New Delhi.

2. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

PRECAST BRICK PANEL AND JOIST SYSTEM

The system consists of two elements, precast brick panels and partially precast joists. Prefab brick panels are made of first-class bricks and reinforced with two TMT bars of 6 mm dia. The joints are then filled with M20 concrete. The length of the brick panels varies from 900 mm to 1,200 mm, depending upon the room size, but the width is normally kept at 540 mm. A minimum of a 40-mm-wide gap is allowed between the bricks to ensure proper cover to the steel bars placed in the gaps. The diameter of reinforcing bars should be increased according to structural requirement. This is a partially precast system where cement concrete is used in the compression zone, steel in the tension zone and bricks are used as filler materials in the tensile zone, and it is suitable for both roofing and intermediate floors.[1] The joists are partially precast and act as small beams to support the pre-cast brick panels. Once the brick panels are placed on the joists, the gaps are filled with concrete to complete the system.

Material and equipment required

Prefab brick panel, partially precast joist, steel/timber moulds, plate vibrator, concrete mixer, mason's tools, light hoisting equipment

CHARACTERISTICS

- Shuttering is not needed, and reusable moulds can be employed multiple times, lowering the mould cost per unit.
- Pre-cast roofing elements enable quicker construction, higher efficiency and reduced time and cost.
- This technique also leads to material savings—approximately 20–25 per cent in cement, 32–40 per cent in steel and 30–35 per cent in bricks.
- Overall, it offers a cost reduction of about 25–35 per cent compared to conventional RCC slabs.[2]

WHERE CAN I LEARN MORE ABOUT THIS?

Rural Technology Park, CBRI–Central Building Research Institute, Roorkee, Uttarakhand

Source: *Compendium of Building Technologies*, Central Building Research Institute and Building Materials and Technology Promotion Council

Photo credit: Garima Kaushal

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Central Building Research Institute, Roorkee, Uttarakhand

SIMILAR TECHNIQUES

FERROCEMENT ROOFING CHANNEL

TO LEARN MORE, see page 102

For more information and to watch video **scan QR code**

Sources:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

3. CBRI's Prefab brick panel system movie, https://www.youtube.com/watch?v=kEeYAa8jOLQ

CURVED ROOFS AND INTERMEDIATE FLOORS

FUNICULAR SHELL ROOF

SHALLOW DOME

FERROCEMENT CHANNELS

FUNICULAR SHELL ROOF

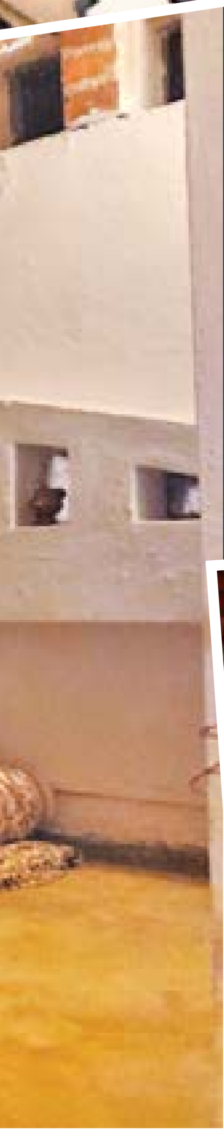
A funicular shell is a three-dimensional catenary supported by a rectilinear base. The roofing system is made up of doubly curved shells made of high compressive strength materials like stone and brick, and supported by reinforced concrete edge beams. A series of these shells in varying geometric configurations, supported on a grid of concrete beams, provides an appealing roof for small to medium spans.[1]

Source: *Building Wise*, CSE

Material and equipment required

Concrete, steel rods, full bricks

Source: *Compendium of Building Technologies*, CBRI and BMTPC



CHARACTERISTICS

A funicular shell roof significantly reduces material usage, offering 60 per cent savings in steel and 35 per cent savings in cement compared to a conventional RCC roof.[2]

WHERE CAN I LEARN MORE ABOUT THIS?

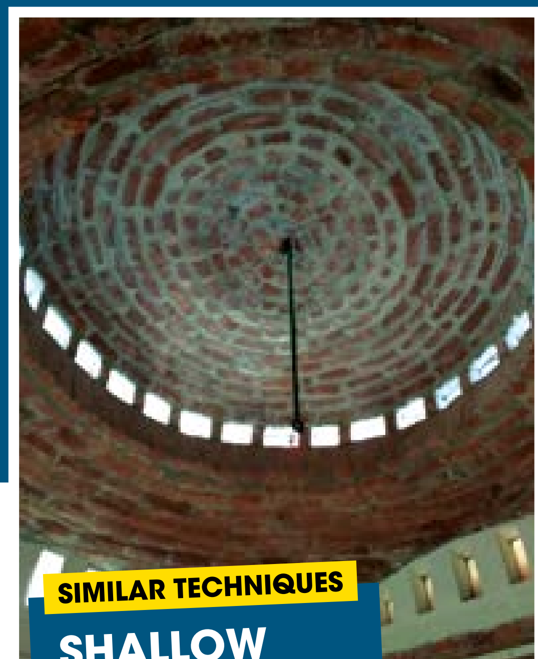
1 Karnataka Rajya Nirmana Kendra, Bengaluru, Karnataka

2. Anangpur Building Centre, Haryana

Source: Red Brick Studio, https://www.facebook.com/photo/?fbid=3170861676285702&set=pcb.3170861836285686

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Aanandaa Farms, Panchkula



SIMILAR TECHNIQUES

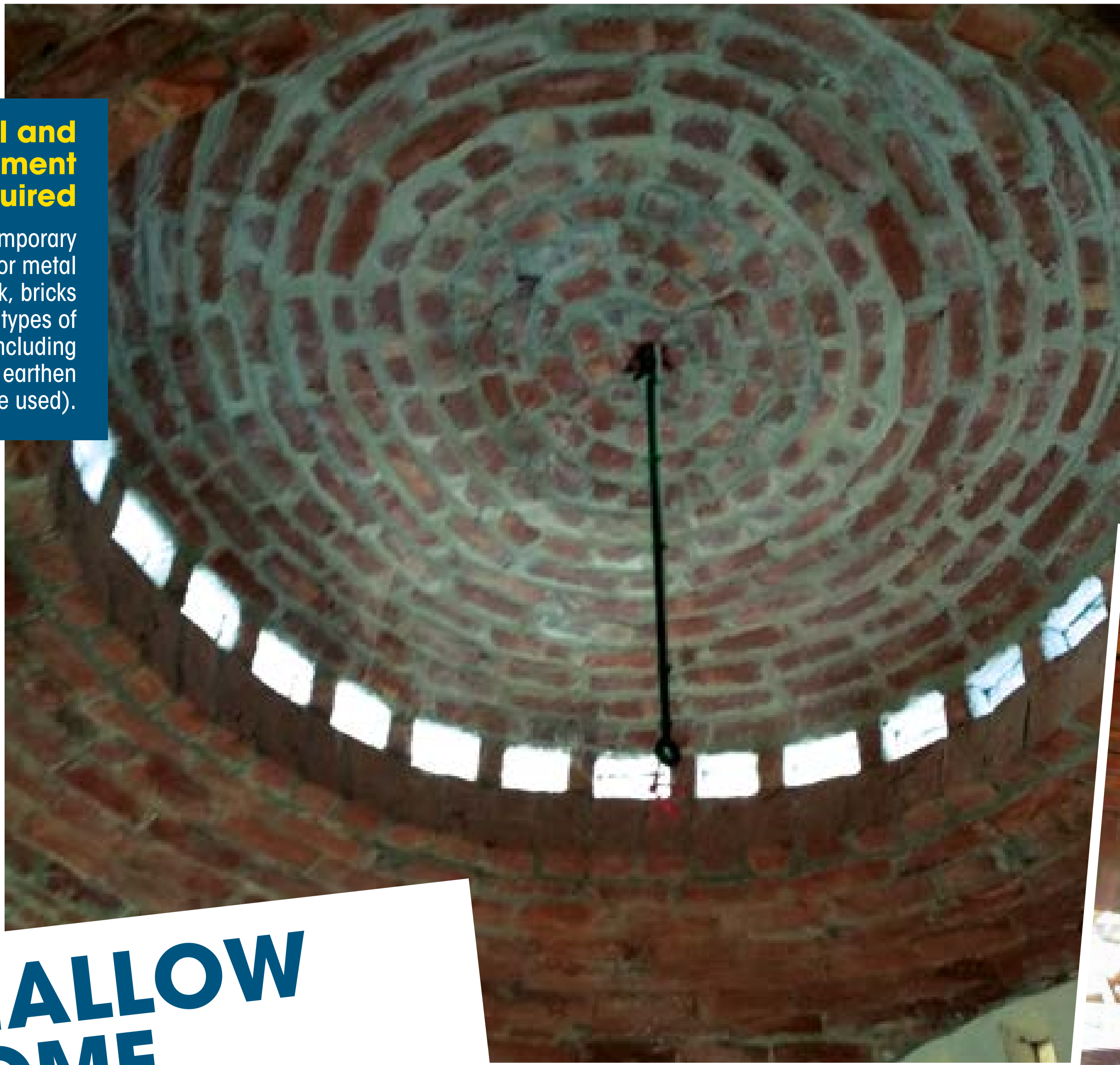
SHALLOW DOME

TO LEARN MORE, see page 98

Sources:

1. Anon. 2021. *Compendium of Building Technologies*, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.



Source: *Building Wise*, CSE

Material and equipment required

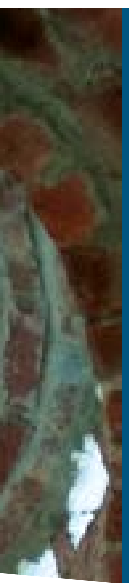
Concrete, temporary wooden or metal framework, bricks (many types of brick including compressed earthen bricks can be used).

SHALLOW DOME

A shallow dome, like the Rohtak dome, is a gently curved roof that forms a slight arch rather than a high or steep dome. Instead of being very tall or rounded like a traditional dome, it has a low rise—meaning the curve is soft and spread out over a wide area. From the outside, it looks like a slightly curved surface, but it is strong enough to cover large spaces without needing beams underneath.

What makes it special is how the forces work within it. The bricks or other building materials are mostly pressed together (in compression), which means they hold each other up without needing steel reinforcement below the slab. This is because the shape naturally carries the weight down to the walls.

Source: *Building Wise*, CSE



CHARACTERISTICS

- Unlike conventional brick masonry, for shallow dome construction, dry bricks are used to increase moisture suction from the mortar into the brick for better initial adhesion. A rich cement mortar with a cement-to-sand ratio of 1:2.5 or 1:3 is used.[1]
- A shallow dome needs a ring beam around its base. This ring beam helps hold the structure together by resisting the outward force (thrust) created by the dome's curved shape. It acts like a belt, preventing the dome from spreading outwards and ensuring stability over time.

WHERE CAN I LEARN MORE ABOUT THIS?

1. Hunnarshala Foundation, Ahmedabad, Gujarat

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

1. Alma Mater School, Jodhpur
2. Mukti Guest House, Sunderbans
3. Aanandaa Farms, Panchkula

Source: *Wisdom to Build*, CSE

SIMILAR TECHNIQUES

FUNICULAR SHELL ROOF

TO LEARN MORE, see page 96

Source:

1. Interview with architect and practitioner of shallow dome construction, Laurent Fournier.

STEP-BY-STEP GUIDE

SQUARE SHALLOW DOME

Demonstration by: Laurent Fournier
Photo credits: Garima Kaushal

1

To start building a shallow dome, ensure that the mortar is mixed correctly, in a 1:5 cement-to-sand ratio for the first layer and a 1:2.5 for subsequent layers. The mortar should also have a liquid consistency to allow for better adhesion.

2

Start laying bricks from one corner. Unlike in conventional brick masonry dry bricks are used for shallow dome construction, to increase moisture suction from the mortar into the brick for better initial adhesion.

3

Place bricks lengthwise, ensuring they overlap joints for structural stability.

4

Hold the bricks in place for some time with your hand for better adhesion. A hammer can be used lightly for gentle vibration for better adhesion.

5 As the courses continue, the angle of placing the brick will get steeper.

6 Hence, to ensure they stick, another brick is tied with a thread which dangles on the end of the wall as a counter weight. The brick that has to be stuck is pinned and left to set.

7 Gradually remove the temporary brick formwork that was supporting the dome from below. Ensure that the structure is fully cured before applying any additional load.

8 The technique can be used for multiple shapes, including circular or rectangular bases.

WATCH THE VIDEO FOR MORE INFORMATION

For more information and to watch video **scan QR code**

For more information and to watch video **scan QR code**

FERROCEMENT ROOFING CHANNELS

Ferrocement roofing channels are thin, pre-made roof pieces shaped like small arches. They are placed side by side over two walls or beams. Once joined together by filling the gaps between them with concrete, they work like strong beams that can hold up the roof or even a floor above. These channels are made using a fine cement mortar and thin layers of wire mesh (like chicken mesh), which spread the strength evenly and reduce the need for heavy steel bars. This makes the roof both lighter and strong, using less material than traditional concrete roofs.

Material and equipment required

Concrete, moulds, wire mesh, steel bars, table vibrator

Source: Sri Aurobindo Ferro Cement Works and Cement Handcrafts

Photo credit: Sugeet Grover / CSE

CHARACTERISTICS

• A ferrocement channel roof provides light-weight roofing. It is a 60 per cent reduction in dead weight as compare to RCC.

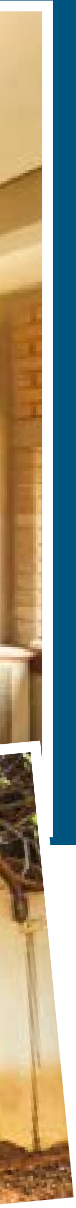
• Pre-casting of roof leads to substantial reduction in construction time and allows for better quality control.

• Compared to RCC roofing, the ferrocement roofing channels offer savings in steel (30 per cent) and cement (35 per cent).

• A ferrocement roof has about 17 per cent lower embodied energy compared to a 10-cm-thick RCC roof (620 MJ/sq. m versus 750 MJ/sq. m). This means it takes less energy to produce and build, making it a lighter and more efficient option.[1]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Auroville Earth Institute, Auroville, Tamil Nadu
2. Ferrocement Society, Pune, Maharashtra
3. Rural Technology Park, CBRI–Central Building Research Institute, Roorkee, Uttarakhand
4. Rural Building Centre, The National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad
5. Tara Nirman Kendra, Orchha
6. Karnataka Rajya Nirmana Kendra, Bangalore, Karnataka
7. Mrinmayee Consultants, Bengaluru, Karnataka Nirmithi Kendra, Karnataka



BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo credit: Sugeet Grover / CSE

Sangath Office by Balkrishna Doshi, Ahmedabad

1. Sahara Institute of Management, Lucknow
2. Indraprasth Resort, Lucknow
3. Sangath Office by Balkrishna Doshi, Ahmedabad (*see photograph*)
4. Development Alternatives office, New Delhi

Precast brick panel and partially precast joist system

SIMILAR TECHNIQUES

PRECAST BRICK PANEL AND PARTIALLY PRECAST JOIST SYSTEM

TO LEARN MORE, see page 92

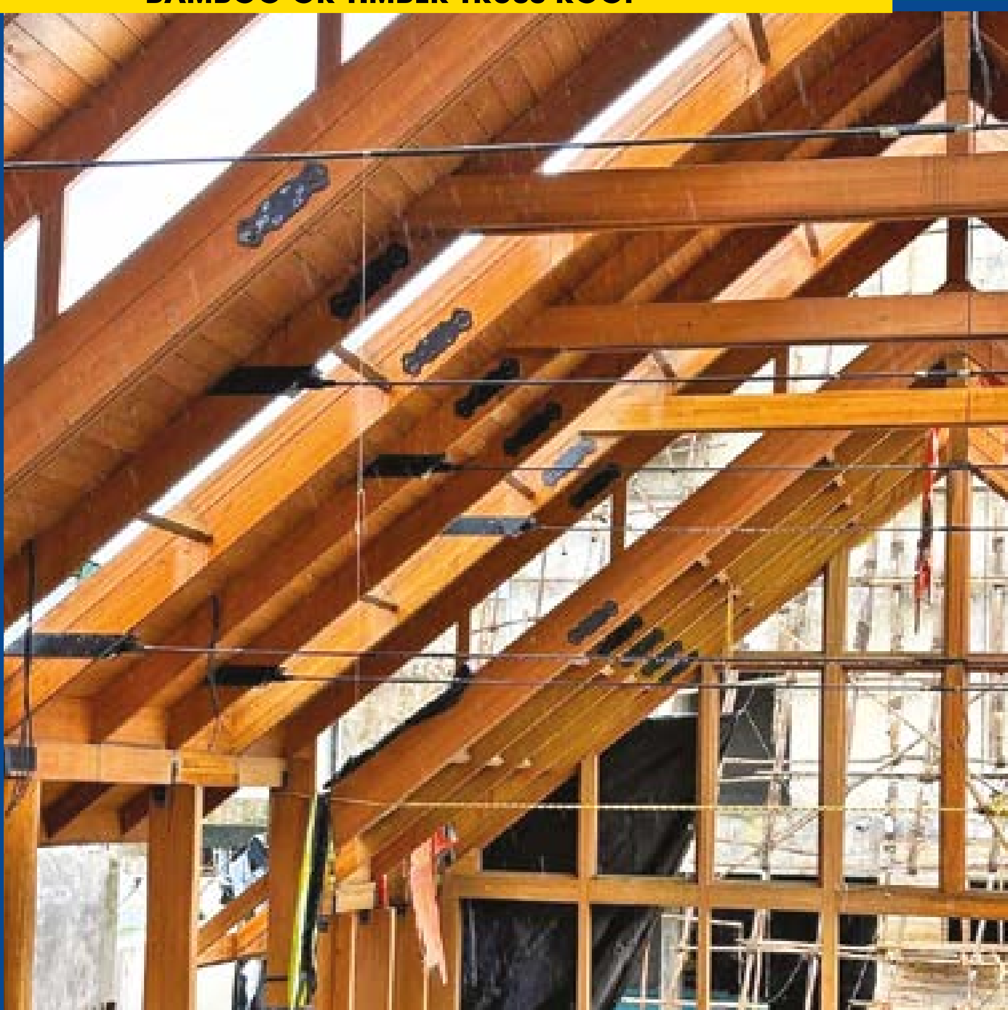
Source:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

ROOFING AND INTERMEDIATE FLOOR TECHNOLOGIES

PITCHED ROOF

BAMBOO OR TIMBER TRUSS ROOF



BRICK PYRAMIDAL ROOF

Photo courtesy: stirworld.com

Material and equipment required

Timber as per design, nails, carpentry tools and plates[2]

BAMBOO OR TIMBER TRUSS ROOF

A bamboo or timber roof truss is a wooden framework that supports the roof of a building. It is usually shaped like a triangle to give strength and stability. Trusses are spaced evenly and connected with long beams called purlins. Modern trusses are often made in factories and use metal gusset plates to join the wood or bamboo, allowing them to carry more weight and span wider areas.[1]

Source: https://www.instagram.com/mayapraxis/p/DCJ67iDSc_R/?img_index=2

Source: https://www.projectpotential.org/earth-nirmaan

CHARACTERISTICS

• Bamboo/timber trusses are light in weight and can be easily handled and lifted into place.

• They have a 60 per cent saving in cost in comparison to reinforced concrete sloped roof, making it a very cost-effective roof system.

WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
2. Geeli Mitti, Pangot (near Nainital), Uttarakhand
3. Project Potential, eArthshala, BiharNirmithi Kendra, Karnataka

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: ritikaawood.com

The Hyderabad Farmhouse, Hyderabad

1. The Hyderabad Farmhouse, Hyderabad (*see photograph*)
2. The Dhajji Cabin, Himachal Pradesh
3. Padmanapuram Palace, Chakala, Thuckalay, Tamil Nadu
4. The Lodge at Wah, guest house in Dohal, Himachal Pradesh
5. Project Potential, eArthshala, Bihar

SIMILAR TECHNIQUES

BRICK PYRAMIDAL ROOF

TO LEARN MORE, see page 108

Sources:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

BRICK PYRAMIDAL ROOF

In coastal areas, marine winds cause steel in RCC slabs or CGI sheets to corrode quickly. These regions also face strong winds, heavy rain and cyclones. A pyramid-shaped roof made from bricks rather than concrete offers a durable alternative to flat RCC slabs under such conditions.

The pyramid-shaped roof is built on-site with bricks and cement mortar. No steel bars are used on the roof. Pyramidal brick roofs are shaped with an equal pitch on both sides and have good aerodynamic features, allowing them to withstand strong winds better than standard gable roofs. As a result, they are ideal for use in coastal areas where strong winds and storms are common. To reduce wind forces, the roof slope is kept at about 16 degrees.[1]

Photo credit: Sugeet Grover / CSE

Material and equipment required

Bricks, mortar, mason tools[2]

CHARACTERISTICS

• Brick pyramidal roofs do not require steel reinforcement, avoiding corrosion from salty coastal winds.

• Their equal sloping sides provide excellent drainage, with no flat surfaces to collect water. Although similar in cost to RCC slab roofs, they offer greater durability and safety in cyclone-prone coastal regions.

• The pyramidal shape of the roof limits vertical expansion and restricts building plans to square or rectangular layouts.

WHERE CAN I LEARN MORE ABOUT THIS?

1. Laurie Baker Centre for Habitat Studies, Thiruvananthapuram, Kerala
2. Rural Technology Park, CBRI–Central Building Research Institute, Roorkee, UttarakhandNirmithi Kendra, Karnataka

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photograph: Sugeet Grover / CSE

Babli ~ Wilderness Farm, Bolpur, West Bengal

1. Rasmancha, Bishnupur, Bankura district, West Bengal
2. Babli ~ Wilderness Farm, Bolpur, West Bengal (*see photograph*)

Source: Red Brick Studio

SIMILAR TECHNIQUES

FUNICULAR SHELL ROOFING

TO LEARN MORE, see page 96

Source:

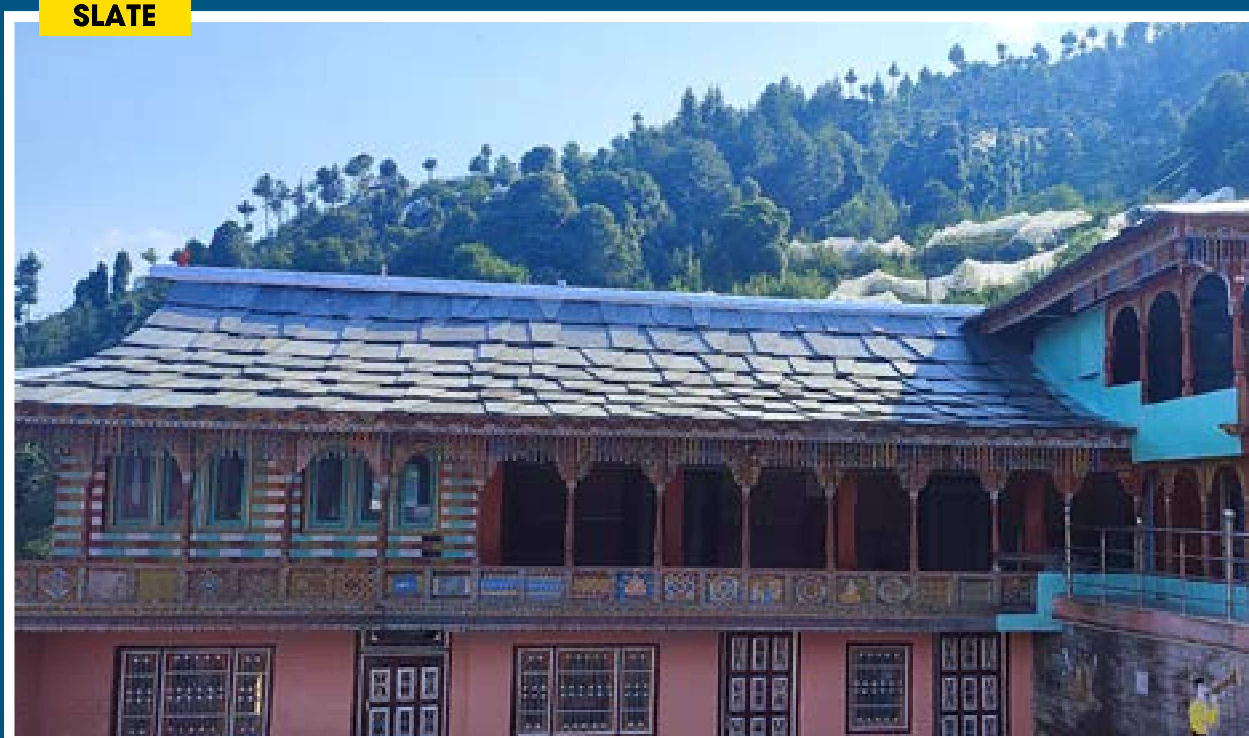
1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

ROOF COVERINGS

TERRACOTTA TILES

SLATE



COUNTRY ROOF TILES

BAMBOO MAT CORRUGATED ROOFING SHEET

Photo credit: Sugeet Grover / CSE

Material and equipment required

Terracotta tiles, base structure

TERRACOTTA TILES

Terracotta tiles such as Mangalore tiles are red roofing tiles made from high-quality hard-burnt clay. They have a curved, interlocking shape that helps rainwater drain off easily and prevents leakage. These tiles are laid in overlapping rows and fixed to wooden or steel roof frames. The tiles are strong, fire-resistant and long-lasting, making them suitable for hot and humid climates, especially in coastal areas. Their clay material also provides natural insulation, keeping buildings cooler in summer.

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Photo credits: Laurent Fournier

HARACTERISTICS

ey are produced in tile factories using moulds and chines to ensure uniform shape, size and quality. The cess involves shaping natural clay into the desired ved form, drying the tiles and then firing them in kilns igh temperatures to make them strong and weather-stant.

is factory-production method ensures better ability and consistency compared to handmade tiles.

IERE CAN I LEARN MORE ABOUT THIS?

aurie Baker Centre for Habitat Studies, uvananthapuram, Kerala

Rural Building Centre, National Institute of Rural elopment and Panchayati Raj (NIRD&PR), Hyderabad

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo courtesy: incredibleindia.gov.in

Chhatrapati Shivaji Terminus, Mumbai

1. Chhatrapati Shivaji Terminus, Mumbai (*see photograph*)
2. Confluence Sports Club, Good Earth Malhar, Kengeri, Bengaluru
3. Shwasam Multipurpose Hall, Aliparamba, Malappuram, Kerala
4. Dhara House, Goa

For more information and to watch video **scan QR code**

SIMILAR TECHNIQUES

COUNTRY ROOF TILES

TO LEARN MORE, see page 116

SLATE ROOFING

Slates, one of the most durable roofing materials, is obtained from sedimentary rocks of limestone or sandstone that is mined and cut to become a form of shingle.[1] They are commonly used in the Himalayan regions of India due to the easy availability of natural slate stone. Slate is a strong, durable, and weather-resistant material that can withstand heavy snowfall, rain, and harsh mountain climates.

Photo credit: Rajneesh Sareen / CSE

Mananeshwar Temple, Manan, Himachal Pradesh

Material and equipment required

Slate tiles, framework, mortar, bolts

CHARACTERISTICS

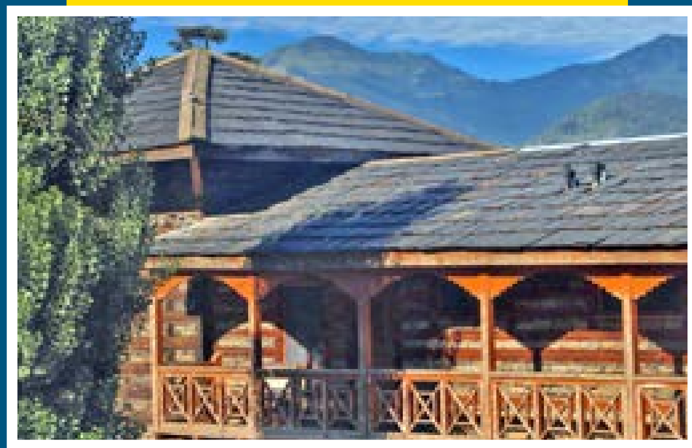
• The slabs are usually flat, thin, and grey or black in colour, and are laid in overlapping layers on wooden roof frames. This overlapping arrangement helps in quick water runoff, preventing leakage and roof damage.

WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh
2. Geeli Mitti, Pangot (near Nainital), Uttarakhand

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Source: https://www.joinpaperplanes.com/the-lego-like-kath-kuni-structures-in-himachal-pradesh/



The Naggar Castle, Himachal Pradesh

1. The Naggar Castle, Himachal Pradesh (*see photograph*)
2. Manali Mud House, Manali, Himachal Pradesh
3. Daafi House, Shimla, Himachal Pradesh
4. Gayatri Temple, Manali, Himachal Pradesh

SIMILAR TECHNIQUES

TERRACOTA ROOF TILES

TO LEARN MORE, see page 112

Source:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

Kandha hut, SCSTRTI, Bhubaneswar

Source: *Wisdom to Build*, CSE

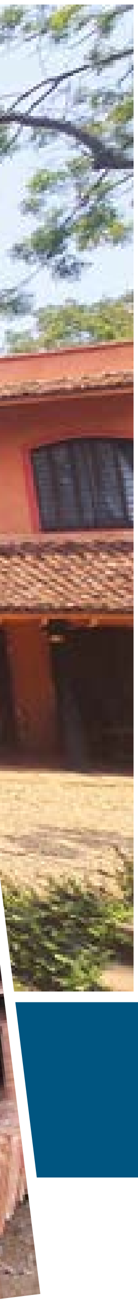
Material and equipment required

Country tiles, framework, nails, carpentry tools, mortar

COUNTRY ROOF TILES

These tiles are made of locally available soil and usually prepared by potters in the village. They are mounted on a wood or bamboo frame. They are semi-cylindrical; the bottom layer of the tile is placed so that the trough of the tile faces upwards, and an inverted curved tile is placed to cover the gap between the two bottom tiles, with its edges resting on the troughs of the bottom tiles.

Photo courtesy: Laurent Fournier



CHARACTERISTICS

The tiles are nailed to wooden sheathing or rafters spaced 300 mm apart. Each tile is about 330–380 mm long and 230–280 mm wide, laid with enough overlap to prevent leakage.[1]

WHERE CAN I LEARN MORE ABOUT THIS?

1. Thannal Natural Homes, Tiruvannamalai, Tamil Nadu
2. Geeli Mitti, Pangot (near Nainital), Uttarakhand

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Photo credit: *Wisdom to Build*, CSE

Santal hut (olah), SCSTRTI, Bhubaneswar

1. Atithi Griha Guest House, Auroville, Tamil Nadu
2. Santal hut (*olah*), SCSTRTI, Bhubaneswar
3. Kandha hut, SCSTRTI, Bhubaneswar

Photo courtesy: Laurent Fournier

SIMILAR TECHNIQUES

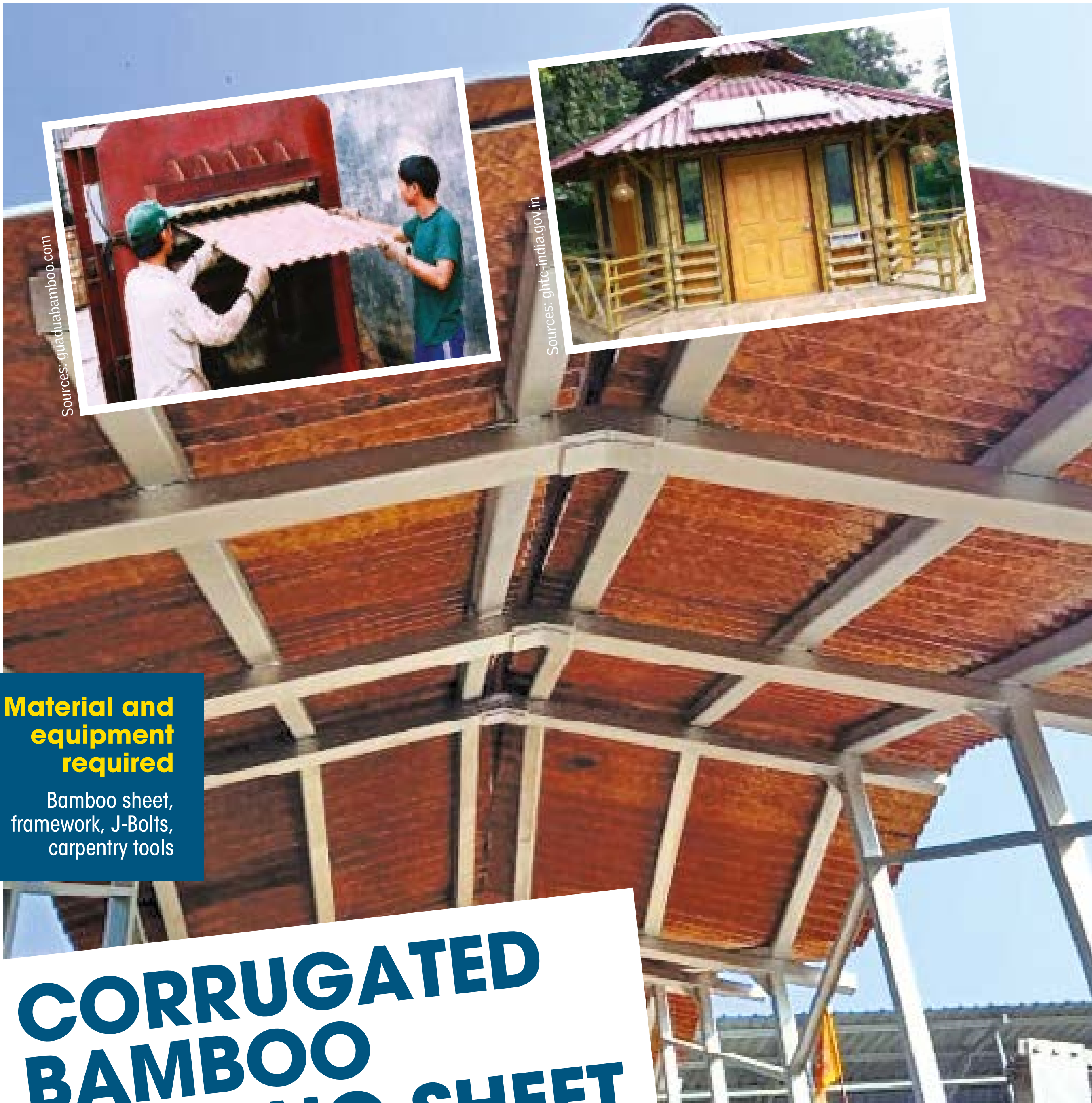
TERRACOTTA ROOF TILES

TO LEARN MORE, see page 112

Source:

1. Anon. 2021. Compendium of Building Technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

Source: timpackgreengold.com



Sources: guaduabamboo.com

Sources: ghtc-india.gov.in

Material and equipment required

Bamboo sheet, framework, J-Bolts, carpentry tools

CORRUGATED BAMBOO ROOFING SHEET

Bamboo mat corrugated sheets are roofing sheets made from woven bamboo mats soaked in resin and pressed into a corrugated shape. They are a strong, sustainable alternative to metal, plastic or asbestos sheets and can be used for houses, sheds and animal shelters. These sheets come in different sizes, are easy to cut as needed, and are made using simple tools like resin applicators and pressing plates.[1]

CHARACTERISTICS

- Bamboo mat corrugated sheets offer better thermal comfort, appearance, strength, impact resistance, and noise and heat insulation compared to plastic or metal sheets.[2]
- Specifications for bamboo mat corrugated sheets: IS:15476-2004
- Specifications for bamboo mat board for general purpose: IS: 13958-1994

WHERE CAN I LEARN MORE ABOUT THIS?

1. Dharmalaya Centre for Compassionate Living, Bir, Himachal Pradesh

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Haridwar Railway Station

Haridwar Railway Station

SIMILAR TECHNIQUES

THATCH ROOF

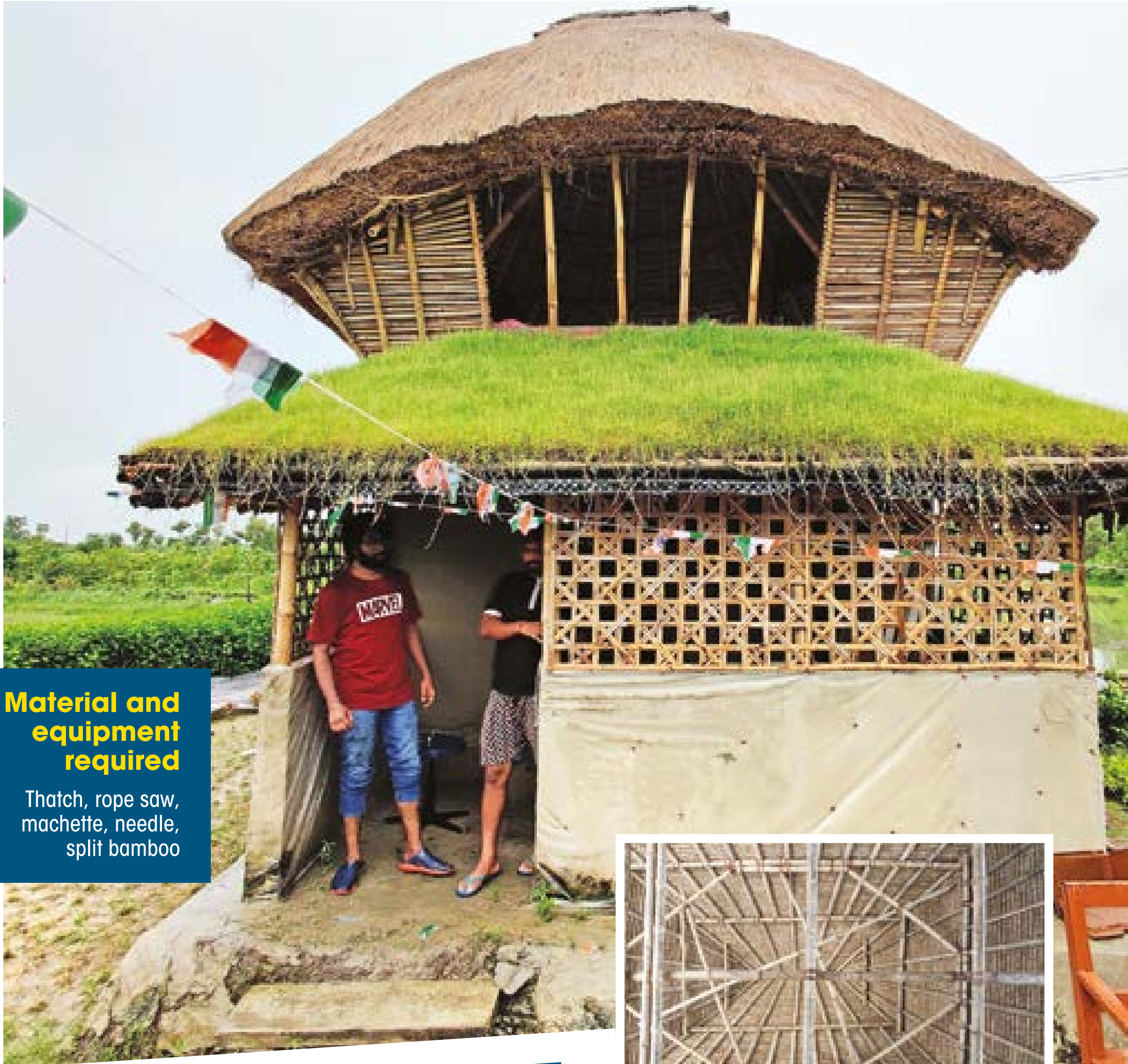
TO LEARN MORE, see page 120

Sources:

1. Anon. 2021. Compendium of building technologies, Central Building Research Institute and Building Materials and Technology Promotion Council.

2. Ibid.

Source: *Wisdom to Build*, CSE



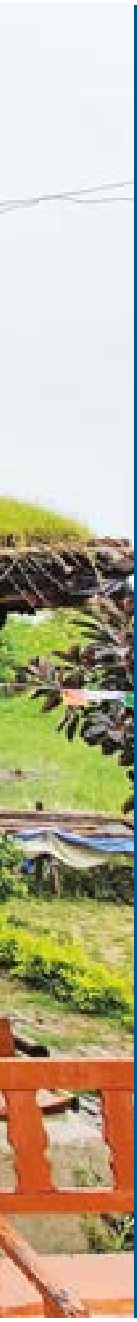
Material and equipment required

Thatch, rope saw, machette, needle, split bamboo

THATCH ROOF

A thatch roof is a traditional type of roofing made by layering natural materials like straw, grass, reeds, palm leaves etc. These materials are arranged in thick layers to create a roof that sheds rainwater and provides insulation. Thatching can be done using different techniques, such as tying bundles to a roof frame or weaving the materials into mats, depending on local customs and available resources. This method is widely used in many parts of the world because it is affordable, eco-friendly and suitable for hot climates due to its natural cooling properties.

Photo credit: Sugeet Grover / CSE



CHARACTERISTICS

- The pitch of the roof varies in different areas depending on the wind velocity experienced in the region.
- They are susceptible to fires and must be maintained on a periodic basis as they are subject to wear and tear by rain and wind.

WHERE CAN I LEARN MORE ABOUT THIS?

1. National Handicrafts and Handlooms Museum commonly known as National Crafts Museum in New Delhi
2. Hunnarshala Foundation, Bhuj, Gujarat
3. Geeli Mitti, Pangot (near Nainital), Uttarakhand

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

Mukti Guest House, Sunderbans, West Bengal, Photo credits: QX design

1. Mukti Guest House, Sunderbans, West Bengal (*see photograph*)
2. National Handicrafts and Handlooms Museum commonly known as National Crafts Museum, New Delhi

SIMILAR TECHNIQUES

CORRUGATED BAMBOO SHEET

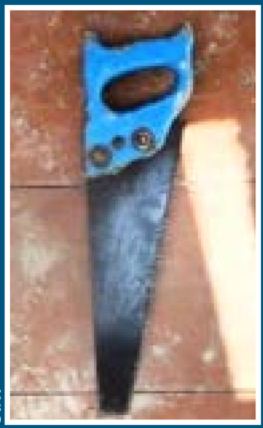
TO LEARN MORE, see page 118

STEP-BY-STEP GUIDE

TECHNIQUE 1: MAKING THATCH PANELS ON GROUND

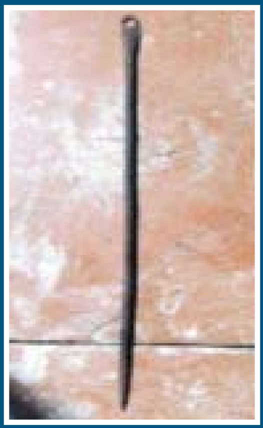
Demonstration location: Purba Sridharpur, West Bengal
Photo credits: Sugeet Grover

Thatch roofs are made from raw materials—mainly agriculture waste such as stalks but could also be tree leaves—available in different parts of the country. There are many methods of making a thatch roof. Here is a demonstration of one such method using rice straw.



Saw

Machete



Needle

1 The raw material for making the thatch is sourced from locally cultivated rice. The stalk is cut at about 20 cm from the ground.

2 The rice straws after the harvest are beaten and refined to make long strands that are held together in a bundle.

3

The straw bundles are eventually placed perpendicularly to two split bamboos and slid between these two members.

4

The bamboo bundle is folded back along the inside of the split bamboo member and tucked into it.

5

Locally made ropes are used to tie the rice thatch to the split bamboos. The worker uses her leg to hold the thatch straight and tie the rope tightly so that it is held together.

6

The panels are eventually stacked and kept protected from heavy rainfall. These are periodically made and distributed depending on local need.

STEP-BY-STEP GUIDE

INSTALLING THATCH PANELS

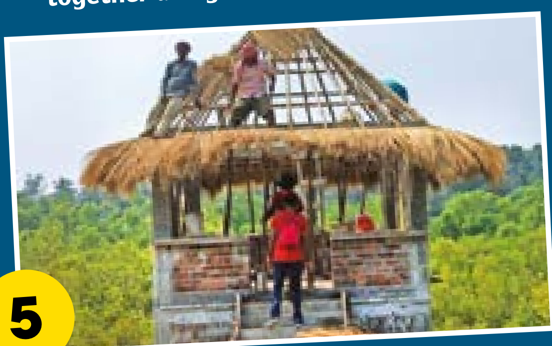
Demonstration location: Purba Sridharpur, West Bengal

1 The bamboo framework is built on top of the base structure which in this example consists of RCC columns and red bricks.

2 The ridge member in the centre of the framework is put up first with a few temporary supports after which the corner rafters are put up to hold it permanently in place.

3 Purlins are placed next followed by the rafters. Each member once placed is tied together using locally made ropes.

4 The thatched roofing is then stacked one over the other and each panel is tied to multiple rafters with ropes made from local straw.



5 The thatch panels are then placed bottom-up with the first layer covering the lower portion of the roof. The process is repeated and continued till the entire roofing structure is covered.

6 The bottom most edges of the thatch panel are trimmed to give it a clean look.

TECHNIQUE 2: MAKING THATCH ROOF USING BUNDLES OF STRAW

Demonstration location: Anil Agarwal Environment Training Institute (AAETI), Nimli, Rajasthan
Photo credits: CSE

1

An understructure for the thatch roof is prepared by most commonly using bamboo, wood and/or metal, but it can be made using many such materials

2

Straw is bunched together into bundles and tied with a rope from one end.

3

These bunches are made on the ground itself.

4

A layer of straw is placed over the understructure and tied to the understructure by means of ropes.

5

The bunches of straw made on the ground are now placed one by one over the layer.

6

Ropes (that may also be made by tying straw together) are placed horizontally, spanning the entire length of the roof over the bundles of straw.

POURED EARTH CONCRETE

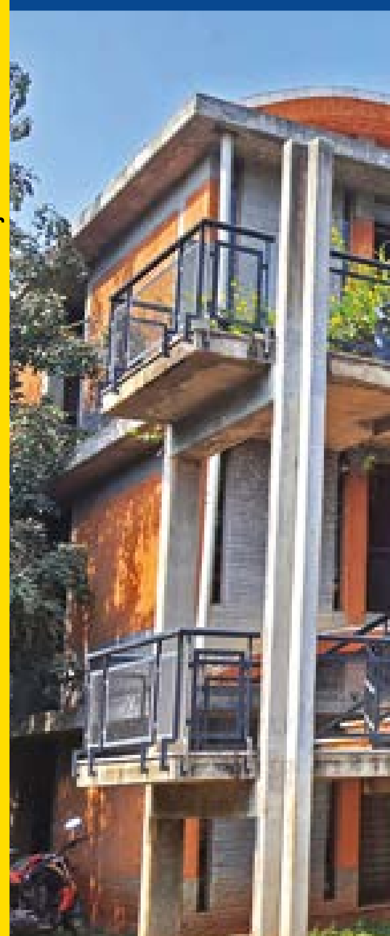
POURED EARTH CONCRETE WALL SAMPLE

Photo credit: Sugeet Grover / CSE

In this technique, soil in a semi-liquid form is poured into formwork similar to concrete. The soil should be sandy or gravelly and must be stabilized. This method, however, is rarely used because the high-water content causes significant shrinkage as it dries, often leading to extensive cracking in the walls. The technology is still under development.

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

HUMANSCAPES, AUROVILLE



Photograph credit: Sugeet Grover

For more information and to watch video **scan QR code**

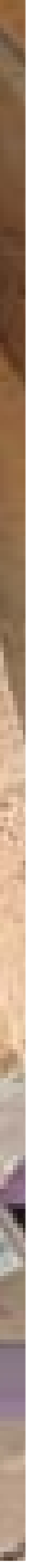
COMPRESSED EARTHEN BLOCKS FOR BEAMS AND COLUMNS

While the most common use of compressed earthen blocks has been in the form of bricks and blocks for walls, they have also been used in beams, foundations, lintel and columns. The advantage they provide is that they cut down the amount of concrete used by substituting parts of the beams and columns with locally sourced materials (often from the site itself) such as soil.

Photo credit: Sugeet Grover / CSE

Composite lintel

Composite beams made from compressed earthen blocks and concrete (the orange part is compressed earthen blocks)



Column and foundation from compressed earthen blocks

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

VIKAS COMMUNITY, AUROVILLE, TAMIL NADU

BUILDINGS THAT HAVE USED THE TECHNOLOGY, MATERIAL OR TECHNIQUE

1. Vikas Community, Auroville (*see photograph*)
2. Auroville Earth Institute (AVEI) laboratory, Auroville
3. Sharanam Centre for Rural Development, Puducherry

4

OPPORTUNITIES FOR MAINSTREAMING NON-CONVENTIONAL TECHNOLOGIES

- Even a modest shift in PMAY housing towards alternative technologies can help revive and support more sustainable construction practices.
- PMAY-G encourages the use of local climate-appropriate materials that reduce carbon footprints and create local employment.
- States such as Assam, Tripura and Rajasthan have successfully applied local-material-based technologies in government housing schemes.
- Post-disaster housing in Gujarat demonstrated the viability of earth-based technologies for large-scale, affordable and resilient housing.

While around 850 million sq. m of built-up area will be added to the building stock through the Pradhan Mantri Awas Yojana Urban (PMAY-U) and Gramin (PMAY-G), it is practical to imagine that a majority of this will be made through conventional construction techniques, given the current market inertia towards fast-paced construction. However, even a modest shift toward alternative construction technologies can help mainstream more sustainable and innovative building practices and help in their revival and sustenance.

Low-carbon technologies can find a more readily acceptable market in rural areas wherein 500 million sq. m will be built under PMAY-G. The PMAY-G guidelines aim to provide pukka houses with basic amenities to all eligible houseless households and households living in kutcha and dilapidated houses in rural areas. It, however, goes onto define a pukka house as ‘a house which is able to withstand normal wear and tear due to usage and natural forces, including climatic conditions, with reasonable maintenance, for at least 30 years’.

This definition of pukka house has been interpreted differently by different states in their housing schemes. For instance, under the Antyodaya Gruha Jojana (AGJ) 2025 by the Odisha government, the criteria for a pukka house emphasize conventional materials and construction methods that involve extensive use of RCC. As per the scheme, a roof utilizing materials like bamboo, mud, straw, grass, tiles, etc. is termed kutcha, and hence deemed unsafe during natural or manmade calamities. It also goes onto specify that the roof of a pukka house is made from RCC.[21]

Sikkim, however, adopts a more flexible approach as their Sikkim Urban Garib Awas Yojana, 2021 defines a pukka house as ‘an all-weather dwelling unit’, as long as it can withstand varying climatic conditions. This broader definition allows for flexibility in the choice of materials and technologies and creates an opportunity to incorporate a diverse range of construction methods, including non-conventional sustainable techniques.[22]

Greening PMAY-G opens the door for sustainable construction technologies

The Framework for Implementation of Pradhan Mantri Awaas Yojana-Gramin, 2022 has a section ‘Greening PMAY-G’,[23] which promotes the use of green designs and technologies that align with local culture, climatic conditions and disaster risks. It encourages the use of locally available materials to reduce carbon footprints while ensuring that houses remain comfortable and resilient. The scheme also aims to boost local employment through the adoption of these sustainable practices.

BENEFITS OF USING LOCAL MATERIALS GO BEYOND SUSTAINABILITY

Using local materials in construction brings multiple benefits beyond just sustainability. It plays a crucial role in strengthening livelihoods and supporting a just transition in the building sector. The construction industry is one of the most labour-intensive sectors in India, with the housing sector alone accounting for a significant share of employment. Technologies that rely on local materials tend to be more skill-intensive and labour-rich, creating opportunities for green jobs in both rural and urban areas. Unlike modern, mechanised construction methods that often displace labour, these practices support job generation and ensure that sustainable housing efforts are inclusive and employment-focused.

Moreover, these methods are often more affordable and accessible. Materials such as earth, stone, agricultural waste and locally sourced vegetation are readily available—sometimes within a one-kilometre radius—reducing transportation costs and dependence on external supply chains. Labour is typically drawn from nearby communities, which not only brings down overall construction costs but also fosters a sense of local ownership and participation in the building process.

These practices also help preserve community knowledge systems, particularly the skills held by women. In many settlements, women are primarily responsible for constructing and maintaining homes, including tasks such as plastering, flooring and processing materials. These skills are passed down through generations, reducing the need for external labour and strengthening local capacities. Community participation is often collective, with neighbours coming together to support each other during construction. This reinforces social cohesion while ensuring that housing development remains culturally rooted and locally driven.

Local/traditional construction is deeply tied to the identity and cultural expression of local communities. The materials, techniques and architectural styles reflect generations of lived experience, adaptation to climate and locally rooted aesthetics. These built forms are more than just functional structures—they carry stories, values and social practices unique to each region. This cultural significance is often celebrated at a national level; for instance, the Republic Day tableaux on 26 January regularly showcase vernacular architecture, traditional homes and region-specific construction practices as symbols of India's rich diversity.

By integrating green and disaster-resilient features, PMAY-G envisions a future where rural housing across India is more sustainable. States are encouraged to motivate willing beneficiaries to adopt these eco-friendly technologies.

The guidelines ask for reduced consumption of cement, bricks and steel by using alternatives, local materials and renewable resources such as bamboo. In this regard the Ministry of Rural Development published a compendium of region-specific house designs as per appropriate multi-hazard-safe green materials and technologies identified. This document entitled *Pahal*[24] has two volumes and includes 108 house designs for 15 states. The states can refer to *Pahal* and *Pahal volume 2*,[25] which has developed prototypes for each housing zone within a state based on climatic conditions, disaster risk factors, local materials and traditional skills.

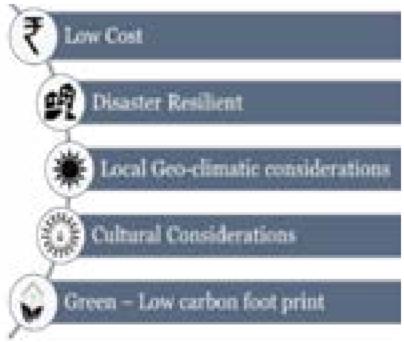
Several states have constructed houses using non-conventional and local construction technologies through housing schemes

Assam has used prototype designs from *Pahal* that promote local-material-based building technologies. Assam has even provided a detailed estimate of a house prototype that utilizes technologies such as split bamboo walls, split bamboo ceiling and wooden trusses.

House constructed in Assam through PMAY-G

Typology for Zone 'B', Assam

House constructed (typology -Zone 'B', Assam)



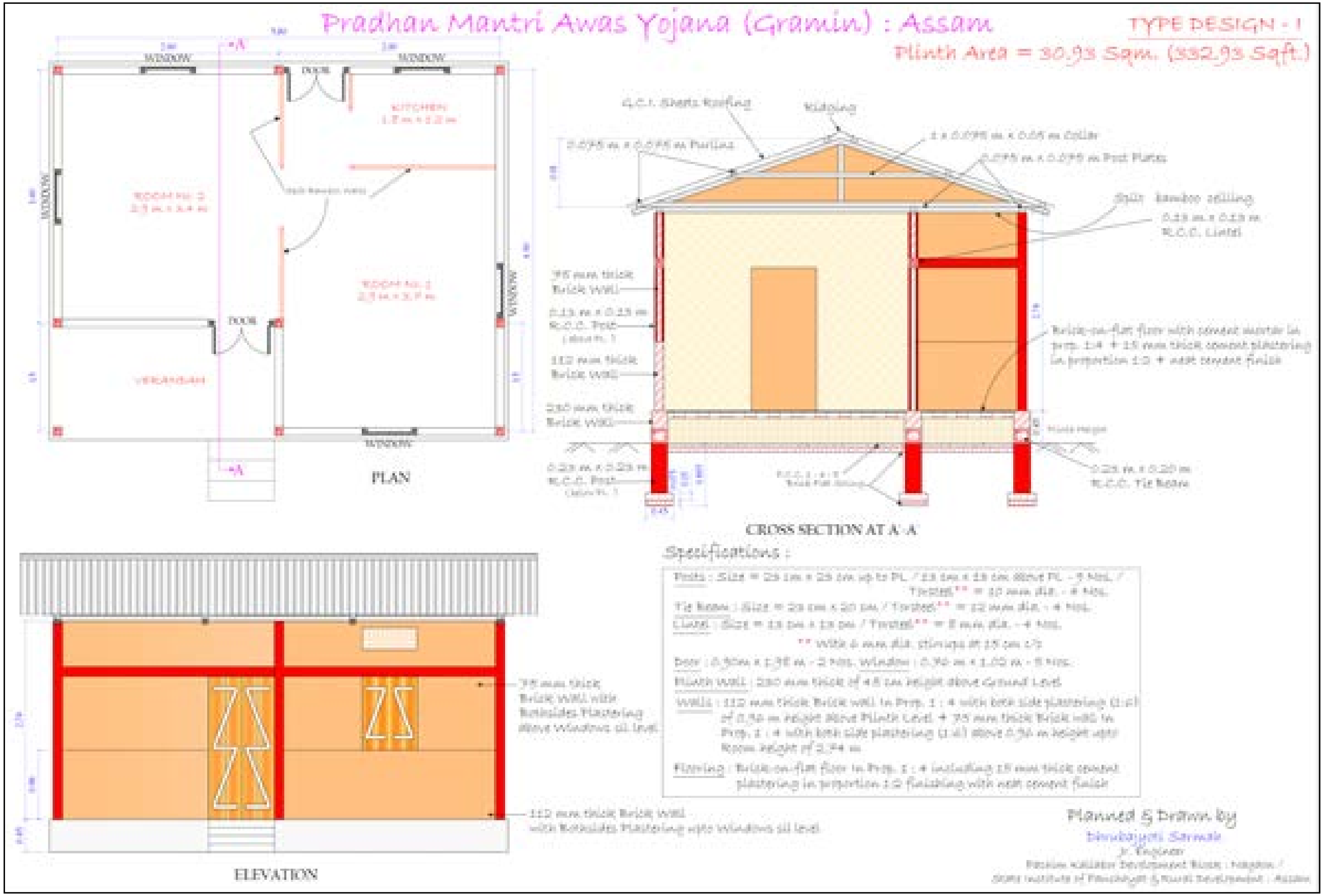
Source: *A Door to Dignity—Fulfilling the Aspirations of Houseless and Poor People of Rural India,* PMAY-G 2022; https://pmayg.nic.in/netiayHome/document/Booklet-PMAYG_A_Door_to_Dignity_English.pdf

Use of bamboo in construction of houses in Assam

Source:

Evaluation of Governance Parameters of Pradhan Mantri Awaas Yojana-Gramin (PMAY-G). NiPFP 2019; https://www.pmayg.nic.in/netiayHome/Document/NiPFP-final-3rd-Report.pdf#:~:text=At%20the%20state%20level%20(Table%204.1)%2C%20Assam,followed%20by%20disha%20(82.05%)%20and%20Madhya%20Pradesh

Detailed estimate of a house in Assam that uses bamboo split walls and wooden truss



Source: https://rural.assam.gov.in/schemes/detail/pradhan-mantri-awaas-yojana-%E2%80%93-gramin#Who%20is%20eligible%20to%20get%20a%20house%20and%20what%20is%20the%20selection%20procedure

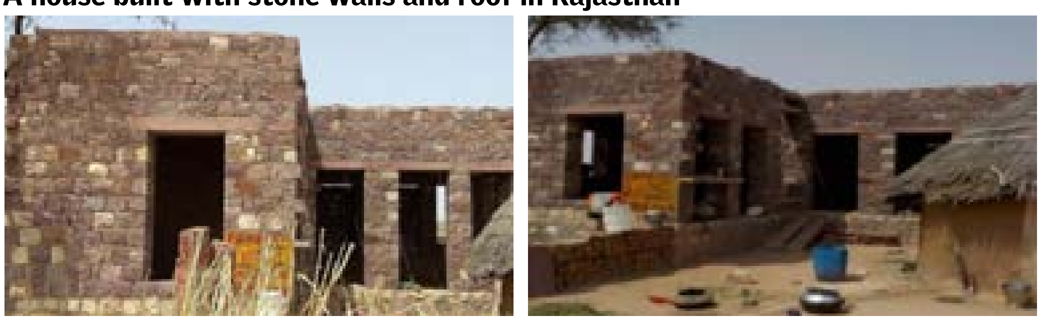
Some PMAY-G houses in Tripura, supported by the block administration, have been built using stabilized mud block (SMB) technology and treated bamboo roofing. SMBs are made by compressing local soil mixed with small amounts of cement or lime, removing the need for fired bricks and lowering both cost and environmental impact. Treated bamboo is used for roofing, making the structures durable and long-lasting. Local Self-Help Groups, comprising largely rural women, have played a key role by producing these mud blocks. This has provided them with income, skills and greater involvement in the construction process.[26]

A pukka house built with stabilized mud blocks and treated bamboo roofing in Dhalai district, Tripura

Source: Building Dreams, One Home at a Time—Shri Marak's Journey with PMAY-G in Tripura, PMAY-G 2024; https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=2077433

A few houses in Rajasthan built through PMAY-Gramin have also used locally available materials such as stone in their walls and roofs.

A house built with stone walls and roof in Rajasthan



Source: Evaluation of Governance Parameters of Pradhan Mantri Awaas Yojana- Gramin (PMAY-G). NiPFP 2019; https://www.pmayg.nic.in/netiayHome/Document/NiPFP-final-3rd-Report.pdf#:~:text=At%20the%20state%20level%20(Table%204.1)%2C%20Assam,followed%20by%20Odisha%20(82.05%)%20and%20Madhya%20Pradesh

Disaster rehabilitation housing has also shown adoption of these technologies

The January 26, 2001 Bhuj earthquake in Gujarat's Kachchh district resulted in the loss of over 13,000 lives and caused extensive damage to the region's housing stock, both within the epicentral zone and across the state. More than a million homes were either demolished or required major repairs. In response, large-scale well-funded and unprecedented reconstruction and retrofitting initiatives were launched.

Within six months, the Gujarat State Disaster Management Authority issued construction guidelines for earthquake-resistant buildings incorporating traditional walling techniques. By December 2001, similar provisions were introduced for stabilized earthen wall structures, accompanied by published protocols for quality assurance. The requirements needed for construction of rammed earth walls, compressed stabilized earth block walls, stone masonry walls etc. were also described.

The recognition of low-carbon construction technologies created an opportunity for their application in rehabilitation housing. This policy shift encouraged wider adoption, leading to at least nine non-profit organizations actively incorporating earth-based construction methods in their projects. As a result, more than 5,700 houses were built using sustainable, earth-based technologies demonstrating their viability for large-scale, affordable housing solutions while also reducing environmental impact.[27]

SCSTRTI HAS RECREATED TRIBAL HOMES AT TRIBAL MUSEUM

Odisha, home to nearly 96 lakh tribal people across 62 communities,[1] has a rich tradition of house construction that reflects the cultural identity and lifestyle of each group. These homes are built using locally available materials and demonstrate a deep connection to the land and climate. To showcase and celebrate this knowledge, the Scheduled Caste and Scheduled Tribe Research and Training Institute (SCSTRTI) has recreated full-scale tribal homes at the Odisha State Tribal Museum in Bhubaneswar. These structures stand as living examples of how traditional construction mirrors the local resources, customs and heritage. The houses demonstrate the techniques and the way of living of the tribes.

JUANG HUT (*injza*) AND DORMITORY (*majang*)

The thatching for the roof Juang hut and dormitory is done with a type of grass available in the nearby forests and soil is sourced from local agricultural fields and nearby land. Extract of mango bark mixed with cow dung is used as a plaster over the walls and acts as an anti-termite agent. Bamboo and different varieties of wood are used for making rafters for the roof.

SANTAL HUT (*olah*)

The Santal tribe is primarily a community of farmers and herders. The buildings are made from locally available materials such as soil and rice straw which is an agricultural byproduct. The same straw is also used for making thatched roofs. Handmade tiles are made from clayey soil in local villages. Multicoloured wall paintings and drawings are done on replastered walls as part of annual festivities..

GADABA HUT (*chhendi dien*)

A central post made of sal wood supports the entire roofing structure in a Gadaba hut. Flooring and kitchen elements such as earthen stoves and plinths are moulded out of locally sourced soil and shaped in circular layers. The circular nature of the walls helps in making the buildings more resistant to earthquakes. The space within the house is divided from the central pole to wall edges for rooms..

KANDHA HUT (*idu*)

Kandha huts are occupied by the Kandha, Kutia and Dongria tribes. The walls, columns, windows, doors and roofing frameworks are built with locally available wood. The walls are made by stacking wooden panels next to each other and sealing the edges with a soil mixture plaster. The flooring is done with mud and cow-dung mixture.

GOND HUT (*loth*)

Gond huts huts are made by the Gond people. The houses use locally available resources such as loamy soil, bricks and wood to make tiles and intermediate floors, which are used as storage and sleeping spaces. The housing clusters are built in a linear pattern..

CHUKTIA BHUNJIA HUT

Chuktia Bhunjia huts are built with locally available materials such as bamboo, mud, wild leaves and straw. They are build with a separate shelter for livestock such as cows and goats. These houses are usually three-quarters bigger than the exhibit model. The doors, windows and attic spaces are made from bamboo. The attic is used to store grains and other utensils. The 'Lal Bungalow', a kitchen space, is built outside the home and is considered sacred and exclusive to the family..

SAORA HUT

Saora huts are dwellings of the Lanjia Saora tribe. This tribe is primarily agrarian and builds livestock shelters within their verandas. They practice terraced and swidden cultivation. Detailed wall-paintings (*idital*) are also done both in the interior and the exterior walls..

Source: *Wisdom to Build*, CSE

5

THE WAY FORWARD

- Housing schemes should open the door to local-material-based and hybrid construction, aligning with PMAY-G's vision of sustainable, climate-appropriate and comfortable rural housing.

- Low-carbon and local-material-based approaches should also be integrated into disaster rehabilitation housing, as demonstrated in Odisha and Gujarat's culturally appropriate, disaster-resilient models.

- Academic and training institutions must incorporate low-carbon technologies into curricula, with formal certification to build a skilled workforce in sustainable construction practices.

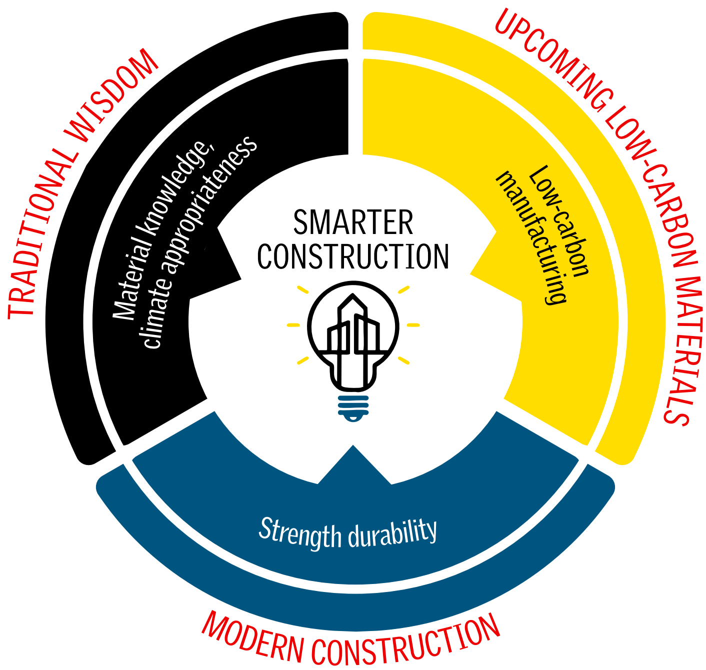
- Centres for innovation and demonstration are essential to research, test and refine hybrid construction technologies for improved comfort, durability and cost-effectiveness.

- Low-carbon alternatives need formal testing, certification and technical standards to build trust and encourage market adoption.

- States should update their schedules of rates to include traditional and hybrid construction materials, legitimizing and mainstreaming these approaches.

Thinking beyond concrete will need a paradigm shift in the way we construct and cannot be expected to happen overnight. It will require a 'smarter' way of thinking before we reach a smarter way of building. Our over-reliance on materials like concrete has led to wasteful building practices and uncomfortable homes, while also draining rivers for sand, lowering water tables, and adding to global warming. It is time to rethink how much we depend on concrete. Building in a smarter way isn't just about being eco-friendly, it is about creating homes, buildings and cities that use resources wisely and work with nature to ensure that the future of construction is not 'set in concrete'.

Figure 2: Need for a combination of traditional wisdom, modern construction and new-age low-carbon materials



Source: CSE

This way of building, however, cannot be applied uniformly everywhere; it depends greatly on the availability of local materials, skill levels of local masons, the area's climate, and its vulnerability to natural disasters. The solution, hence, will lie in picking up the 'wisdom to build' inherent in local construction and merging it with the convenience and durability that is achieved by modern construction practices while also embracing new low-carbon materials and technologies evolving in the fringes. The answer is a form of hybridization that not only reduces our reliance on high-embodied-energy construction methods, but is also practical and accessible—neither restricted to the underprivileged who adopt these technologies out of necessity, nor exclusive to the ultra-wealthy who can afford premium versions despite their high maintenance demands. Integration of local building materials, techniques and skills with mainstream technologies can give multiple co-benefits. It can reduce material intensity and environmental footprint, create climate-appropriate shelters and improve thermal comfort.

Housing schemes need to open their doors for local-material-based and hybrid constructions

The section 'Greening PMAY-G' in the PMAY-G guidelines asks for reduced consumption of cement, bricks and steel by use of alternatives, local materials and renewable resources such as bamboo. It also envisions a future where rural housing across India is more sustainable. State housing schemes need to align with this vision by internalizing and incentivizing low-carbon technologies in new self-built housing for the several co-benefits linked with thermal comfort, climate appropriateness and circularity. This will provide beneficiaries with a wider choice to integrate several sustainability features in new houses or new extensions.

This should not just be limited to state housing schemes but also into schemes such as disaster rehabilitation etc. For instance, Odisha in its Urban Housing Mission developed guidance on houses that are disaster resilient and use local material and labour. This was done to provide transit houses to beneficiaries after cyclone Phailin hit the state in 2013. The model was also implemented in Gujarat after the devastating 2001 earthquake wherein traditional construction wisdom was blended with modern earthquake-resistant techniques, creating culturally appropriate and technically sound housing solutions.[9]

Skilling schemes and institutions need to recognize alternative technologies by inculcating them into curricula

Academic and training institutions need to design their curricula to include low-carbon technologies and materials, helping to expand knowledge and develop new skills within the construction sector. At the same time, local labourers and masons, who are increasingly shifting towards conventional brick-and-mortar and concrete methods, should be trained in these techniques through dedicated skill-development centres. For this to be effective, certifying skills in these alternative technologies is essential. Once masons and workers receive proper certification in traditional and hybrid methods, vocational education and skill-development bodies can implement structured skilling programmes, ensuring a steady workforce proficient in sustainable building practices.

Centres for innovation and demonstration are essential to advance hybrid technologies

Dedicated innovation and demonstration centres are vital to promote hybrid construction technologies that blend traditional knowledge with modern advancements. These centres enable research, testing and refinement of materials and systems, helping improve thermal comfort, durability and cost-effectiveness. Successful pilot projects have already shown the potential of combining conventional materials like concrete with newer alternatives.

Low-carbon alternatives need to be certified for better acceptability

One of the main barriers to the widespread adoption of alternative building methods is the lack of proper testing and certification. Although scientific studies have shown that many of these techniques offer better thermal comfort and resilience against disasters, the absence of formal standards and verified performance data has limited their acceptance in the market. It is essential to thoroughly assess these technologies for their effectiveness in providing thermal comfort and withstanding disasters. Following this technical assessment, low-carbon alternative technologies and the associated skills should be officially certified to build trust and encourage wider use.

Update schedule of rates for formal adoption of these materials

To promote wider adoption, states must incorporate traditional and hybrid construction technologies and materials into their official schedules of rates for procurement. Doing so will not only encourage their mainstream use across public and private construction projects, but also legitimize these approaches within institutional frameworks.

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Construction technologies developed over years of experimentation and refinement—often using locally sourced, easily-replenishable and renewable materials—have produced solutions best suited to local climates and challenges. Yet these time-tested, low-carbon methods are rapidly losing ground to fast-paced construction technologies. The market's focus on speed and shorter deadlines over long-term performance is a short-sighted approach, overlooking the impact on thermal comfort and energy consumption over a building's lifetime. As a result, these alternative technologies have been pushed to the margins, and treated as novelties rather than the norm.

With the rising demand for low-carbon options, these once-marginalized technologies are poised for revival. Limited awareness and fragmented knowledge, however, have slowed their adoption.

This guidebook brings together information scattered on the fringes, offering insights for governments, homeowners and the construction industry. Through practical guidance and policy pathways, it equips stakeholders to integrate these lesser-used methods into the mainstream, ensuring the future of construction is not set in concrete but evolves toward less carbon-intensive practices.

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