- Case Study Title: Vocational training centre – Cheerville, an ecoconscious residence

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| Project Name | Cheerville |
| Location | Jain Farms, Bagalur, Bengaluru, Karnataka, India |
| Climate Zone | Tropical Savanna Climate/ *ASHRAE*: Zone 3A (Warm-Humid) |
| Latitude/Longitude | 12°51'48.5"N 77°51'29.8"E |
| Building Type | Residence |
| Floor Area [sqm] | 220 square metres |
| Building Height [m] | 4M to 6M (varies based on spaces) |
| Number of Storeys | Single storey with mezzanine. |
| Completion Year | Completed August 2025 |
| Project Team | **Architects:** Rosie Paul and Sridevi Changali<br>**Site Architect:** Oviya M<br>**Masons:** An all-women masons' team: Rupa, Saroja, Yentalakshmi and Nagina |

*mock-up experiments and other research-based experiments could be included as case study, aside from actual building construction projects if similar information could be provided.

1. Project Description

| Project Overview |
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Cheerville is a pioneering project that serves as an example of a zero-cement, completely off-grid, eco-conscious residence prioritising low-carbon construction and community empowerment. Situated in Jain Farms near Bengaluru, it is a pilot initiative for a completely cement-free construction using earthbags, shuttered cob, bamboo, and lime plasters, and other natural materials sourced locally. The project is powered entirely by solar energy, achieving full off-grid functionality with minimal reliance on non-renewable sources, and features a 16,000L cement-free semi-underground lime water tank that harvests rainwater to minimise dependence on the public water supply. Beyond a testament to Earthen architecture, the building serves as a hands-on training and capacity-building hub for local women masons, equipping them with skills in green livelihoods and fostering their financial and professional independence, thus redefining their roles in construction. The design of the dwelling balances traditional construction practices and innovation - two earthbag domes joined by shuttered cob, wattle and daub, and bamboo roofs anchor the site, harmonising with the natural surroundings. Cheerville illustrates circularity in its construction, with most building materials returning to the earth at the end of their life due to the biodegradable nature of natural materials.

2. Climate & Site Context

| Basic Climate Conditions | | |
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| Temperature | Annual Average | 23.8°C |
| | Annual Range | 12.5°C (April) - 35.4°C (December and January) |
| Relative Humiditiy | Annual Average | 71.5%- 72% |
| | Annual Range | 11.5% (March) to 99.6% (July/August) |
| Annual Degree-Days<br>(ASHRAE Standard 169-2020) | | HDD18°C: <100 (minimal);<br>CDD18°C: high (Bengaluru is cooling-dominated) |
| *The data collected is from the nearest local meteorological source, Hosur, Tamil Nadu, as ASHRAE data is not available for the site location. The closest location for which ASHRAE data is available is Bengaluru, Karnataka, which shows variations in climatic data. However, HDD and CDD mentioned are of Bengaluru. | | |
| **Climate Analysis** | | |
| Hosur has a tropical savanna climate with distinct wet and dry seasons, and its high elevation makes it more moderate than the surrounding plains. Winters are mild and pleasant, with the coolest month being January, while summers are hot and humid, with the hottest month being May. The city receives rainfall from both the northeast and southwest monsoons, with the wettest months being October, September, and August. | | |
| **Site Analysis** | | |

The site is in a semi-rural community on the border between Karnataka and Tamil Nadu. The site spans roughly 1000 square metres and features an orchard and a biodiversity pond. The green buffer on the site supports microclimate stability and biodiversity, while creating a calm, secluded environment through low-carbon construction methods.

| Passive Cooling Strategies (please tick implemented passive cooling strategies) |
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| ☑ Building Orientation & Form (site orientation, building shape, etc.)<br>☑ Envelope Design (insulation, air-tightness, shading, window system, thermal mass, etc.)<br>☑ Natural Ventilation (cross ventilation, stack ventilation, night ventilation, etc.)<br>☐ Evaporative Cooling (direct/indirect evaporative cooling, etc.)<br>☐ Ground Cooling (geothermal, ground-coupled systems, basement/underground space,etc.)<br>☐ Radiative Cooling (cool roof, night sky radiation, radiant barriers, reflective surfaces, etc.)<br>☑ Nature-based Solutions (green roof/wall, tree shading, etc.) |
| ☑ Others (human behavior, clothing, semi-passive (fans, etc.)) |
| Description (please describe one strategy per box – you can add more boxes below if needed) |
| **Building Orientation and Form (Respecting the site contours and tree cover)**<br>A permaculture specialist devised the building orientation to demonstrate a holistic, climate-responsive, and ecologically integrated design that prioritises cooling, biodiversity, and community interaction.<br>The house is positioned on the east-west axis, facing south to take advantage of prevailing winds and natural light while minimising harsh sun exposure on the south side. The building form has been developed to reduce surface area exposure and promote efficient thermal mass distribution. |
| **Envelope Design (CSEB: thermal mass, shading, minimal openings on harsh exposures):**<br>The use of earthen construction techniques, such as shuttered cob and earthbags, for the curved wall provides high thermal mass, which absorbs heat during the day and slowly releases it at night, stabilising indoor temperatures in spaces such as the bedroom. These thick, monolithic walls are about 40 centimetres thick and act as thermal barriers, buffering extreme outdoor temperature fluctuations and maintaining indoor conditions throughout the diurnal cycle.<br>The shuttered cob wall creates straight flush walls with consistent density and thermal properties, while optimising material use with clay, sand, lime, and fired brick powder.<br>Other spaces on the mezzanine level use wattle-and-daub walls to continue the envelope's natural material palette while providing breathability. The light weight of the wattle-and-daub construction makes it suitable for upper-level construction and non-load-bearing partitions.<br>Cheerville achieves natural ventilation through strategic design principles, including verandahs surrounding the bedrooms, reducing heat penetration through the envelope. |

**Natural Ventilation (cross and stack ventilation):**
Within the earthbag domes, a low-tech system to enhance the stack effect has been introduced through creating small openings in the PVC pipe air passages in the walls at a strategic low height and introducing a hot air exhaust at a higher level in the dome, accelerating the pushing out of hot air and pulling in of cold air. Additionally, the narrow PVC pipes through which air moves in the dome allow the air to cool by expanding as it enters the room via the venturi concept, further enhancing cooling.
The building layout encourages continuous air movement from lower openings to elevated exits, drawing cool breeze through terracotta jali in the living rooms. The design eliminates the need for mechanical fans, relying on passive airflow, natural convection and space organisation to maintain thermal comfort and natural ventilation.

3. Passive Cooling Design Details

4. Active Components

| Active (Hybrid) Cooling Strategies<br>(please describe one strategy per box – you can add more boxes below if needed) |
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| The residence is primarily solar-powered, ensuring that all electrical demands, including lighting and limited mechanical cooling, are met sustainably. Since the interior temperature is well maintained, wall fans or portable standing fans have been provided in the case of unexpected higher temperatures to aid existing passive systems employed. |

5. Performance Data

| Cooling Energy Use |
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| The building operates without active air conditioning. Cheerville has been optimally designed to reduce cooling energy demand through the increased thermal lag of earthen materials and the integration of natural ventilation. Pedestal fans powered by the solar grid have been used during peak summer months to enhance airflow in the dome's interior.<br><br>A solar harvester has been installed within the earthbag domes, optimising daylight penetration and minimising the need for artificial lighting until nightfall. A controlled penetration of light reduces internal heat built up while maintaining visual comfort. With earth as the key material throughout the spaces, the walls and roof assist radiative cooling.<br><br>In conclusion, these low-carbon strategies create a balanced environment driven by renewable energy and a synergy between design and natural building materials. The system combines minimal mechanical energy with a passive management system through material selection, ensuring energy efficiency without compromising comfort or sustainability. |
| Indoor Thermal Comfort |

The client has been living in the residence since 2024, since the construction. She describes the interior spaces as naturally calm and comforting. The house does not require any mechanical ventilation systems, even during peak summers and artificial lights are used only after nightfall, after 7.30 pm in summers and 6.30 pm in winters.

## 6. Financial Data

| Cost Benefits |
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| Due to the recent completion of the project, the financial gains from reduced active cooling measures are yet to be documented. However, based on user experience, it is clear that there is little to no use of active cooling measures, and any additional requirements are met by electricity generated from solar energy, which then ensures ROI on the initial investment in solar panels and other passive systems installed. However, as this project stresses low-tech solutions to enhance passive cooling, financial investment during construction was also minimised. |

*Please try to extract passive cooling cost and savings; however, if it is difficult, please annotate the premise. (e.g., the calculation includes the cost for both passive heating and cooling, etc.)

## 7. Passive Cooling Operation

| Maintenance Requirement |
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| Cheerville's passive cooling systems require low but regular maintenance to sustain optimal performance. Annual inspections are necessary to check for cracks or water ingress in lime or mud plaster finishes, particularly after monsoons. Occasional patching or reapplication of lime plaster (Thappi, Lohi, or Araish) may be needed, as these breathable surfaces help ensure durability and regulate humidity. Verandah roofs, eaves, and bamboo elements should be kept free of debris to maintain shading and drainage. Prompt attention to any settlement cracks or seepage ensures the envelope's thermal mass and vapour permeability remain uncompromised, supporting long-term occupant comfort and system longevity. |

## 8. Lesson Learnt / Recommendations

| Technical Challenges, Solutions and Achievement |
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| The client's aspiration to create a cement-free, low-carbon farmhouse was the project's biggest challenge. Every technique employed required testing, trials, and exploration of natural materials. For instance, due to the site's susceptibility to termite infestation, the addition of natural fibre as a reinforcement to increase tensile strength had to be avoided; instead, Cheerville employs a unique approach of using animal fibre (dog hair) in the mortar (made of Surkhi (powdered brick), Earth, lime and natural additives). Due to the adoption of locally available materials as natural additives, such as ink nut and jaggery, the construction requires precision and care during the drying phase to maintain structural stability, achieve waterproofing and prevent cracks. In return, these natural materials improved flexibility, bonding, and thermal-stress resistance. The construction challenges, such as building earthbag domes with skilled women masons, were mitigated through extensive on-site training and participatory supervision. Achievements at Cheerville include building the earthbag domes with upcycled plastic woven vegetable bags, effective lime waterproofing using Lohi, a traditional Rajasthani plastering technique, and construction of a 16,000L cement-free water tank and an off-the-grid residence that employs rainwater harvesting and solar energy production. |

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| Financial Challenges, Solutions and Achievement |
| Using earth as a building material typically requires skilled labour and additional materials, such as lime, which can increase costs. However, training the local labour team in handling and constructing with these materials not only reduced expenses but also enhanced their skill set. The techniques of earthen construction chosen also took into consideration ease of skilling and replicability. Sourcing earth in situ further minimised costs. |
| Other Challenges, Solutions and Achievement |

Beyond the technical dimensions, Cheerville encountered substantial social, logistical, and cultural challenges. The employment of an all-women construction team initially faced gender bias, scepticism, and a dearth of skilled female labour. To address these issues, continuous capacity-building initiatives and participatory learning sessions (PLAs) were implemented to foster confidence, ergonomic safety, and leadership skills among the team members.

Innovative material sourcing strategies were essential, including upcycling plastic woven sacks into earthbags and using dog hair as plaster. Furthermore, the limited understanding of natural construction methods within the surrounding community was transformed through proactive engagement and site visits, turning scepticism into community pride.

The project's success exemplifies the possibility of harmonising ecological integrity, gender equity, and craftsmanship, thereby establishing a precedent for inclusive and regenerative construction practices. The overarching objective is to empower the community through training in green livelihood initiatives, thereby equipping them with the skills to construct their own homes using readily available materials.

9. Free Description

| Free Description |
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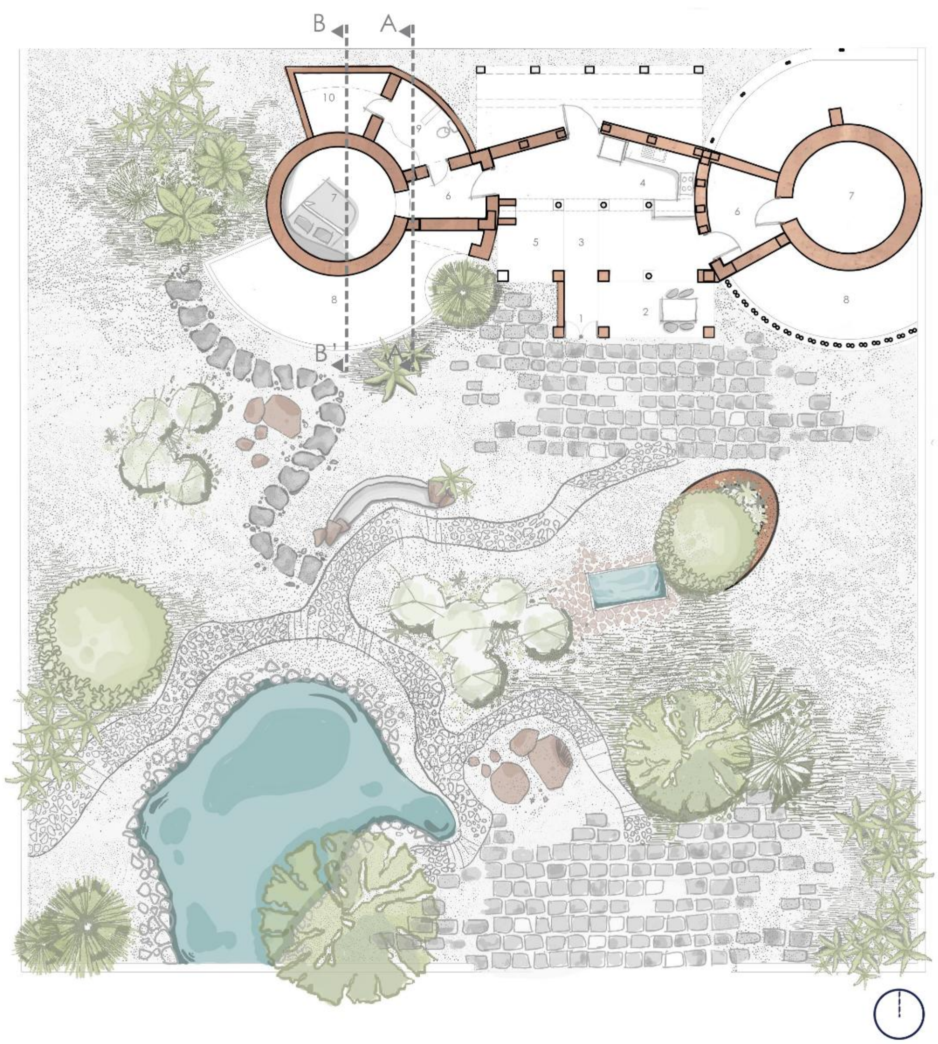
| The Cheerville construction model offers valuable insights for replicability, design, and material specification. Its zero-cement, off-grid approach leverages local, renewable resources like earth, bamboo, lime, and recycled materials, making it environmentally sustainable and cost-effective. Earthbag and shuttered cob techniques provide high thermal mass, crucial for maintaining indoor thermal comfort without active cooling, which is ideal for warm-humid climates. Bamboo, while exportable, is preferred locally for ecological and economic reasons, emphasizing the importance of adapting material choice to regional availability. The model also highlights the importance of tailored training programs to empower local communities in green livelihoods, ensuring social sustainability alongside ecological benefits. Though hyperlocal by nature, the adaptable methods and design principles can be customized for other regions with similar climates and material ecosystems, requiring careful soil, climate, and cultural contextualization. Cost insights reveal affordability |

through modular design and material choice, encouraging broader adoption of regenerative building methods. This comprehensive case study serves as a practical guide for sustainable architecture practitioners globally.

## 10. Annex

### Supporting documentations

SITE PLAN




1 – Entrance

2 – Dining

3 – Courtyard

4 – Kitchen

5 – Living room

6 – Antiroom

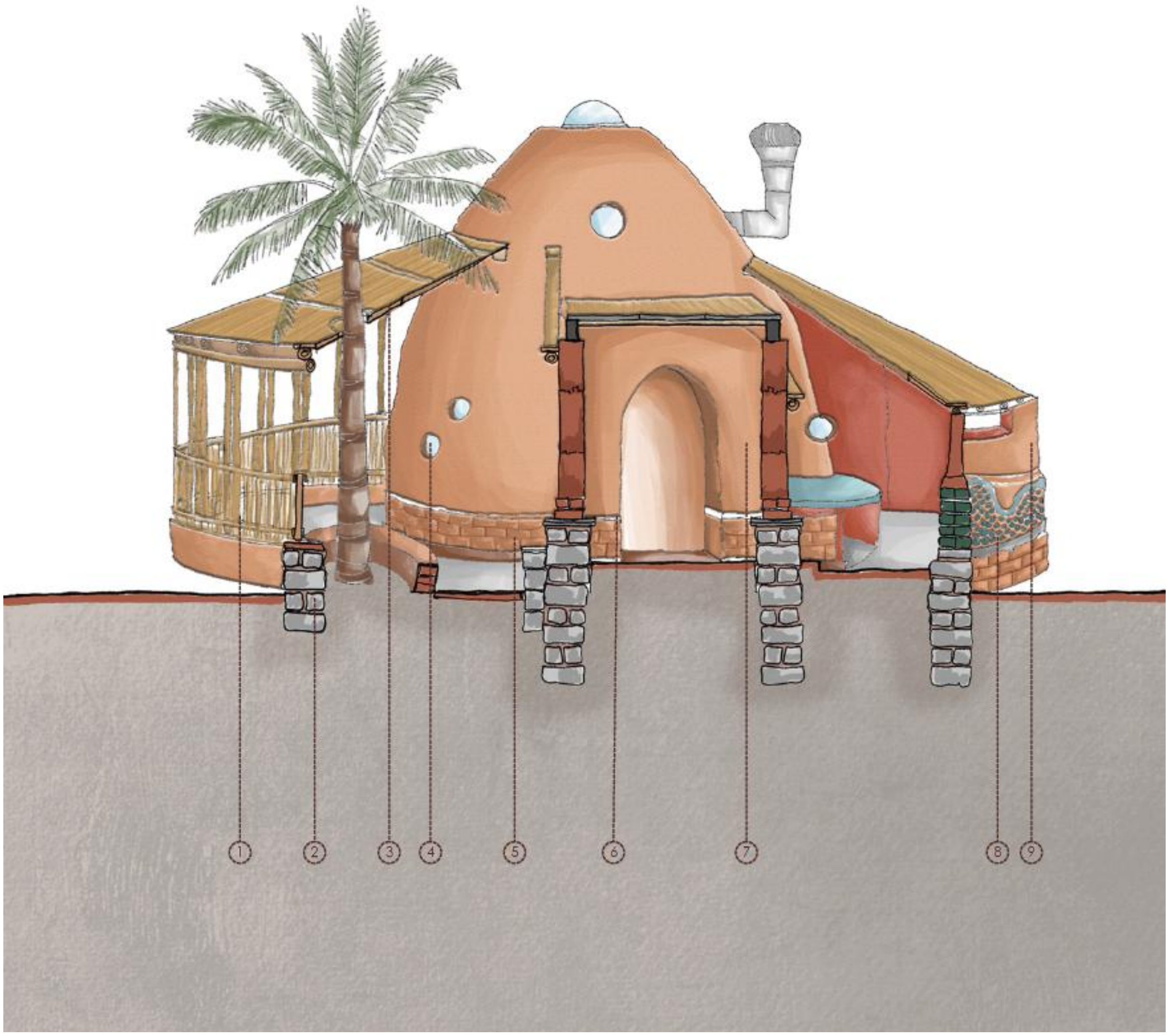
7 – Bedroom (earthbag dome)

8 – Verandah

9 – Wash closet

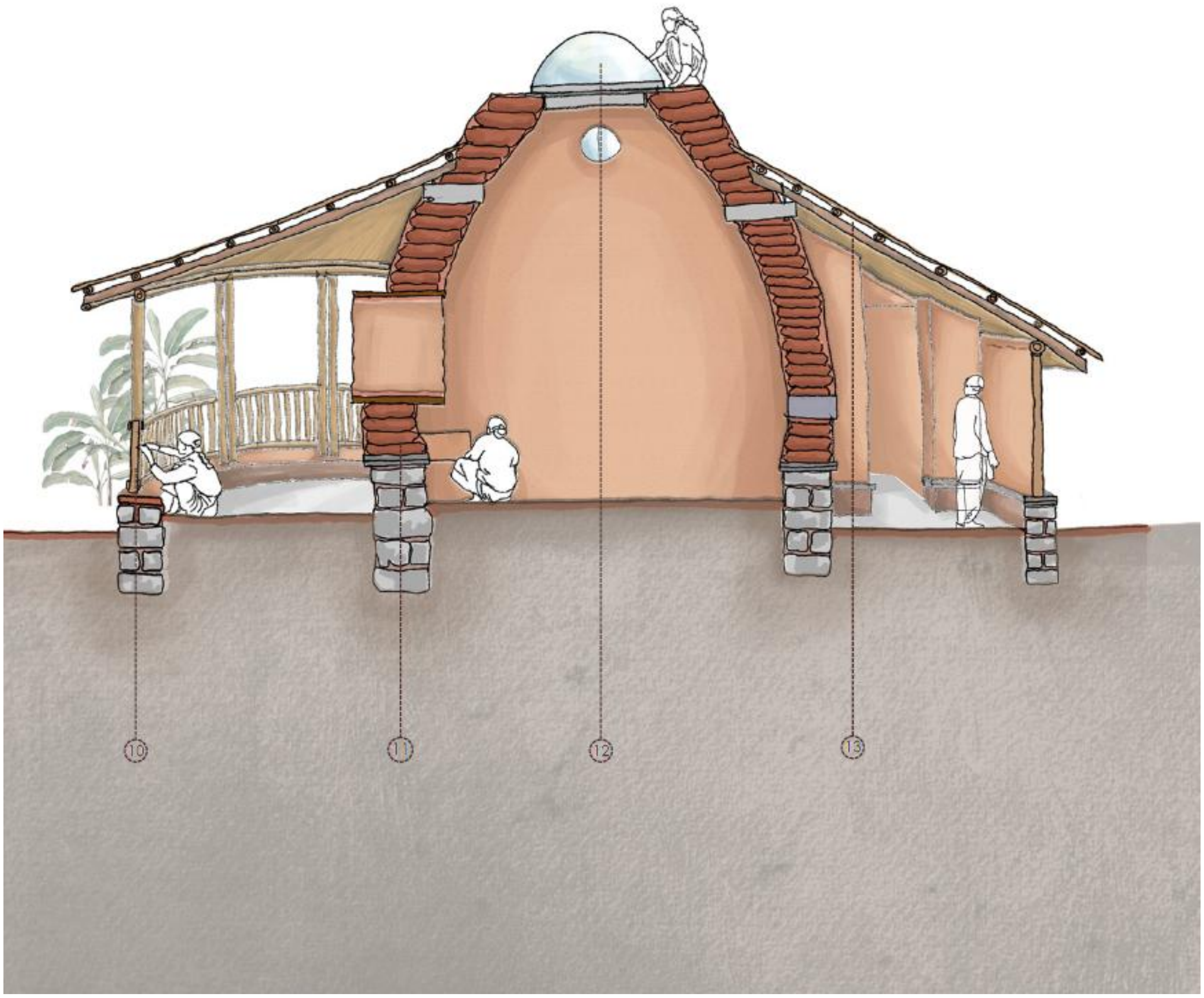
10 – Outdoor bath/ utility

SECTION AA’



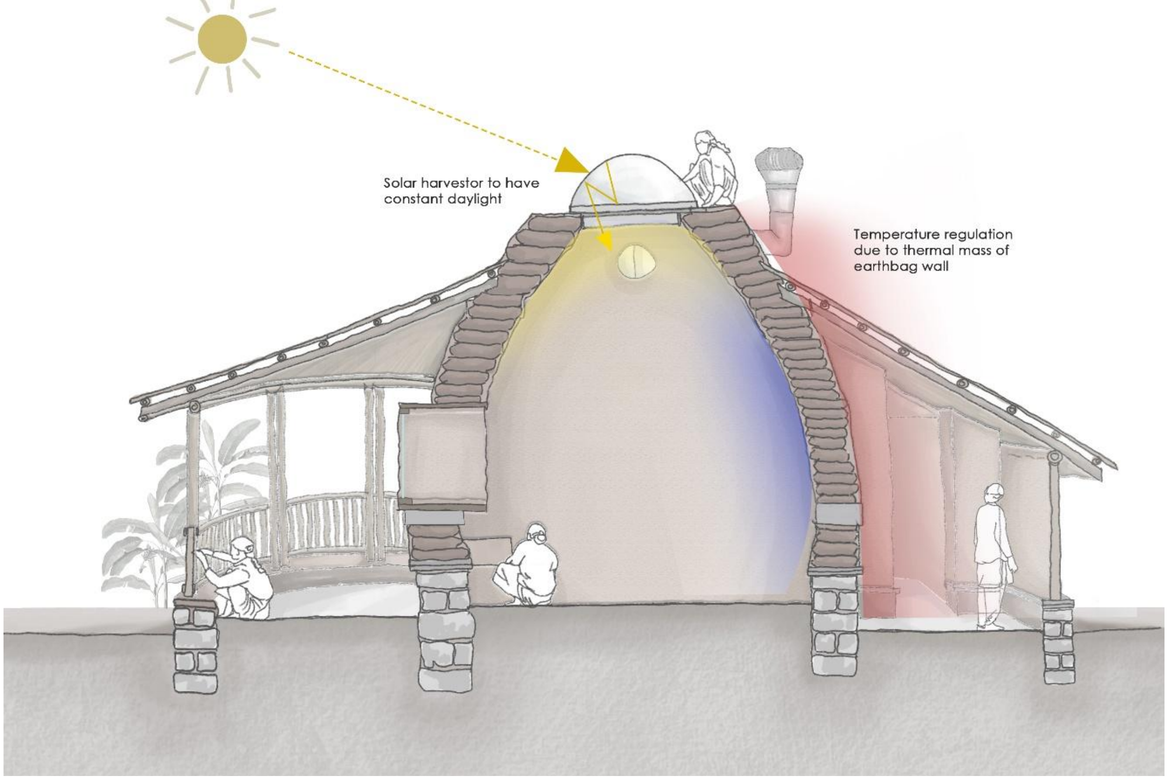

1. Bamboo grill
2. Stone foundation
3. 3-layered flattened bamboo roof
4. Vent pipes
5. Stone masonry
6. Stone plinth
7. Mud and lime plaster over earthbag
8. Bottle wall
9. Wattle and daub

SECTION BB’

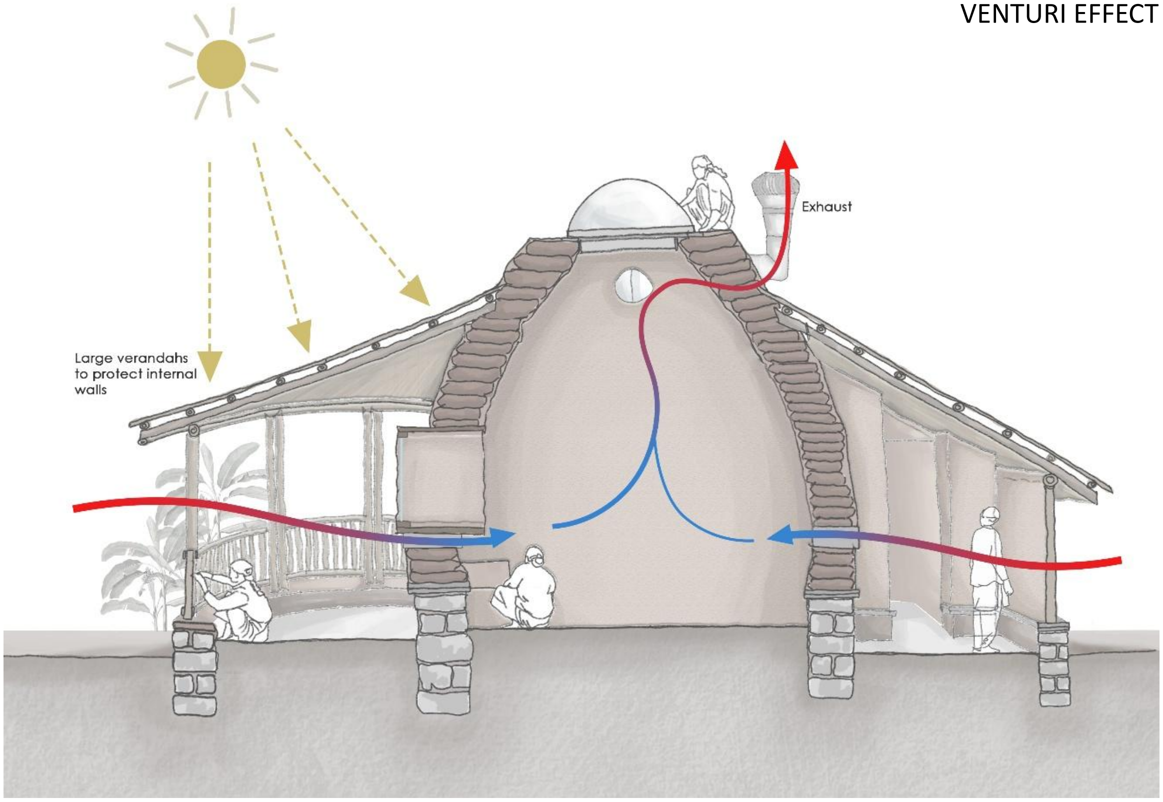



10. Bamboo grill
11. Earthbag masonry
12. Solar harvester
13. 3-layered flattened bamboo roof

TEMPERATURE REGULATION




VENTURI EFFECT



The image displays verandah outlining the earthbag dome (master bedroom). The verandah is a semi enclosed space with bamboo parapet walls.

Note: This image has been AI modified to remove site debris.

An aerial view of Cheerville

Note: This image has been AI modified to remove site debris

Note: This image has been AI modified to remove site debris.

Left image: Fire bricks finished with thappi plaster for the walls.
Right image: Wattle and daub walls lining the living room with a central courtyard.

## 11. Citation

| Citation |
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| 1. Paul, R., Changali, S., Pangal, S., Battepatti, A., & Oviya, M. (in progress). "Empowering Women as Agents of Change in Climate Resilience." To appear in the proceedings of the Sustainable Built Environment (SBE) Conference, ETH Zurich. [Publication in progress]<br>2. https://www.intbau.org/keeping-building-traditions-alive-masons-inks-work-with-women-masons-in-india/<br>3. https://youtu.be/VGsB3Zwyx0E?si=TlD4IFj2-xDYWkMt<br>4. https://youtu.be/2HZpW-m4U6k?si=NGe1gb8FiLTk9VfS |

## 12. Contact

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| --- | --- |
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