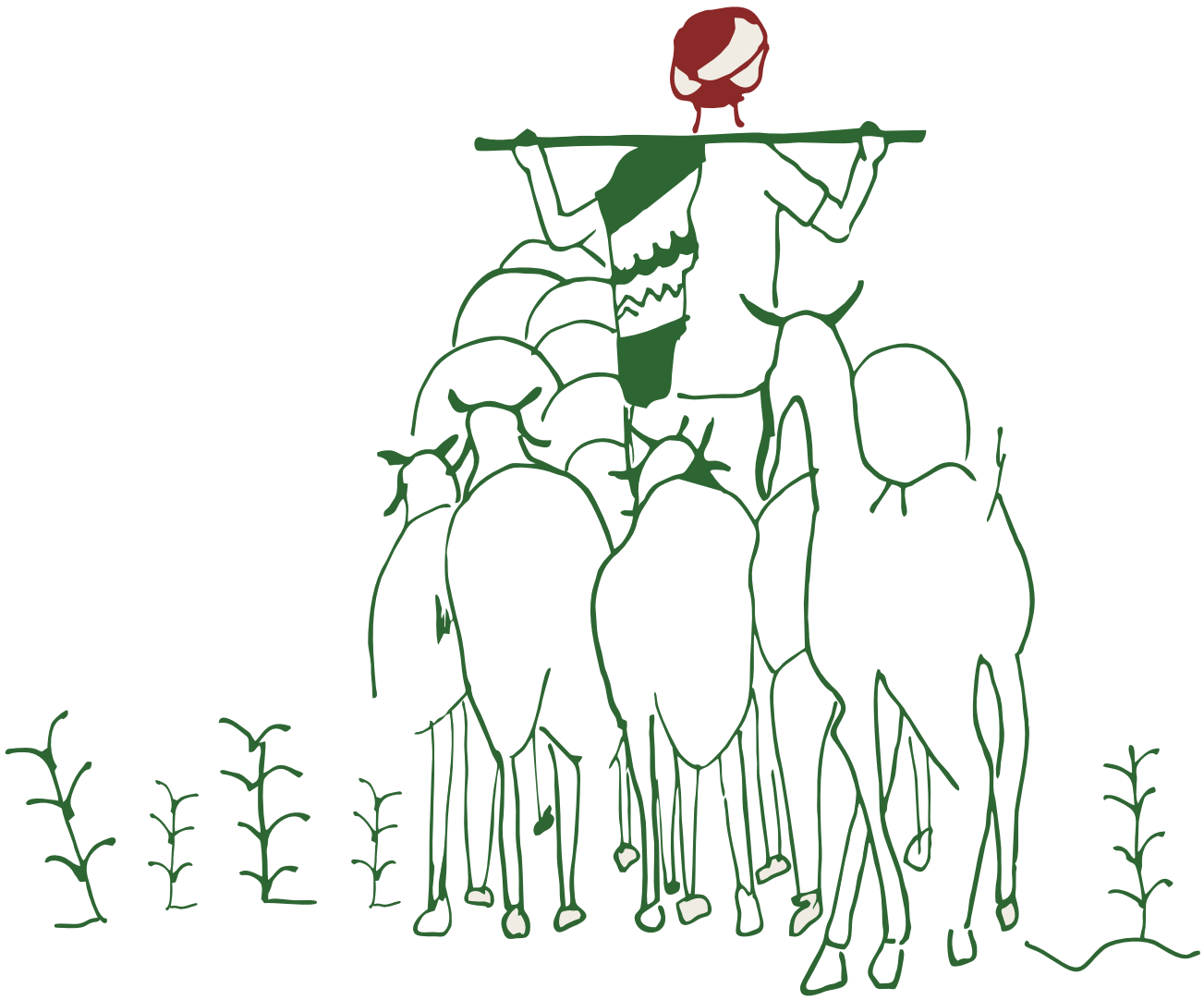
Thermal Insulation Enhancement Project in Lahaul and Spiti

madra

by

Samakhya

CONTENT



EXECUTIVE SUMMARY

This case study details a groundbreaking initiative led by the Social Alpha Foundation and Samakhya Sustainable Alternatives Pvt. Ltd., aimed at addressing the critical issue of thermal conductivity in the high-altitude regions of Lahaul and Spiti, Tabo. Over a compact project duration of six days, the foundation introduced a suite of innovative products— Agribiopanels™, Magra, and Honeycomb—that significantly improve the thermal and acoustic insulation of building interiors. This report encapsulates the project's introduction, solution strategies, installation procedures, and the impactful outcomes achieved, emphasizing the environmental and functional benefits of the adopted solutions.

INTRODUCTION

The project was conceived to tackle the challenges posed by the harsh climatic conditions of high-altitude locales, which severely affect the living standards and energy efficiency of the built environment. The Social Alpha Foundation identified Lahaul and Spiti, Tabo, as the project site, leveraging its expertise to implement a sustainable and innovative solution to enhance thermal insulation.

Site Area — *Lahaul and Spiti, Tabo*
Project Duration — *6 days*
Product Introduction — *Agribiopanels™*
Magra
Honeycomb

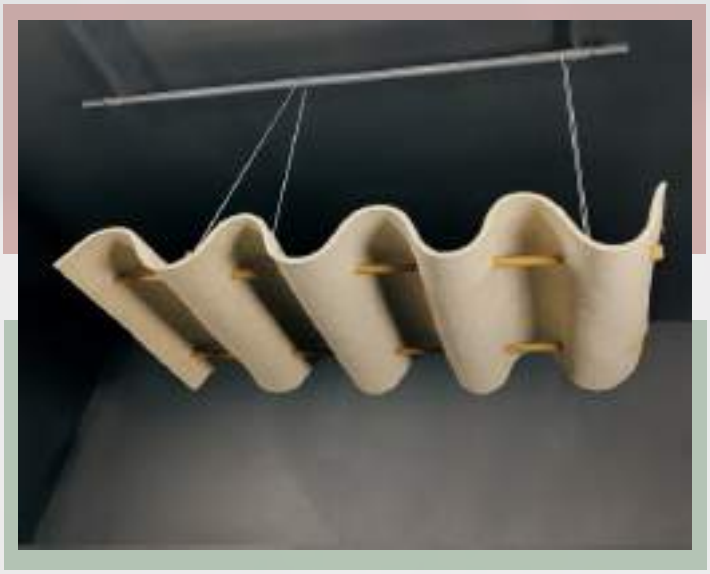
1. Agribiopanels™

Agribiopanels™ are a revolutionary building material, composed of 96% biomass and offering exceptional thermal (0.0195 W/m K) and acoustic (40 Db+) insulation. These panels are fire-resistant, moisture-resistant, and termite-proof, surpassing traditional materials in insulation and load-bearing capacity by 40% and 3x, respectively. Moreover, they play a crucial role in carbon sequestration, embodying the project's commitment to environmental sustainability.

Some Picture of Agribiopanel with Different Finishes.

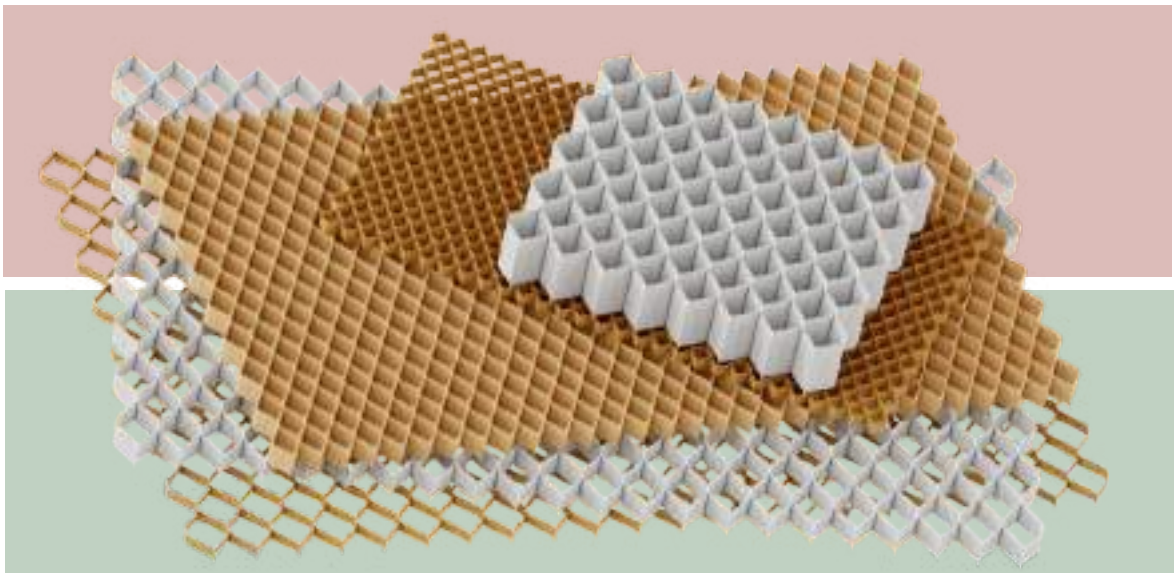
2 Magra

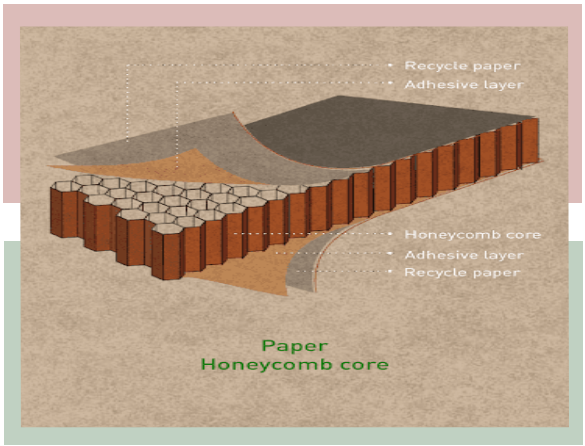
A 100% Natural fiber- based Insulation made using discarded animal residue. Magra is a safe, healthy and sustainable alternative to toxic insulation such as Stonewool and glasswool. Magra offers a low Thermal Resistance value of 0.2926 Km2/W and a minimum 30-40% better Thermal and Acoustic performance than mainstream insulation. Magra regulates the atmospheric air by absorbing VOC instead of emitting it.



3. Honeycomb

Hedrad Paper Honeycomb Superstructure Panels leverage extreme mechanical properties that offer moisture, chemical and impact resistance, apart from vibration dampening. The result is improved performance in doors, platforms, fixtures and custom furniture amongst others uses. An emerging alternative for interiors and furniture, Hedrad offers custom services as per design or manufacture of ergonomic and creative products for utility like furniture





4. Sensor

The project employed advanced sensor technology to accurately monitor and analyze the performance of the installed solutions, focusing on temperature variance, VOC levels, and air quality indicators.

We had used Active building's Sensor the Result data they have 99% accuracy on that.

They have the facility of the Real time Monitoring.

SOLUTION

Customised solutions were developed for both walls and ceilings, incorporating the innovative materials in a layered configuration to maximise insulation effectiveness.

Wall Solution: A multi-layered composition of Agribio Panels™, Magra, and Honeycomb, creating a robust insulation system.

Ceiling Solution: A similar approach with adjusted thicknesses, tailored for ceiling applications to ensure optimal thermal and acoustic insulation.

Solution For wall

Create 4 Inches Air gap + Product

Product solution:-

11 mm AGP + 20 mm Magara + 40 mm Honeycomb + 20 mm Magra + 40 mm Honeycomb + 20 mm Magra + 11 mm AGP.

Solution For ceiling

Create 3inches Air gap + Product

Product solution:-

9 mm AGP + 20 mm Magara + 40 mm Honeycomb + 20 mm Magra + 40 mm Honeycomb + 20 mm Magra + 9 mm AGP + 10 mm Magra batt (Exposed)

PROCEDURE

Two distinct procedures were employed to assemble the product panels:

1. Box Method
2. Individual Pasting Method.

Box Method

A pre-assembled box structure of AGP was used as a container for sequentially adding and glueing the insulation layers.

Individual Pasting Method

Layers were individually glued, providing flexibility for configurations with fewer layers, albeit at a higher resource, time and cost.

INSTALLATION

The installation process was meticulously designed for walls, ceilings, and sensors, ensuring precision and effectiveness in insulation performance enhancement.

1. Installation of wall
2. Installation of ceiling
3. Installation of Sensors

1. Installation of Wall

Detailed measurements are taken and panels are made accordingly, runners and panels are pasted while maintaining the air gap, incorporating innovative joint designs and structural integrations for stability and insulation integrity.

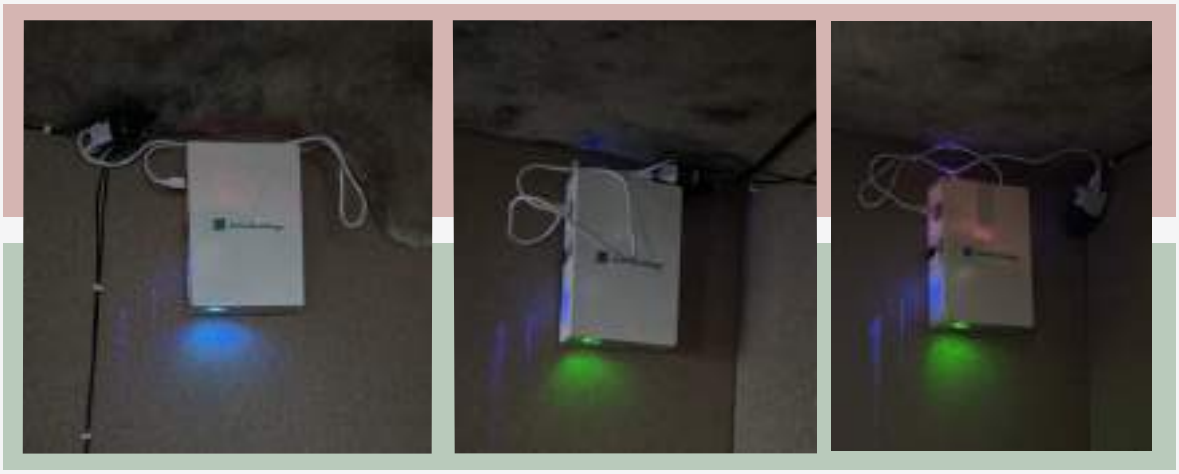
2 Installation of Ceiling

Detailed measurement and assembly techniques were utilised, appropriate slots are cut on the wall panels of the ceiling frames. Panels ,frames slots are put up together and lastly covered with 10mm Magra batt

3. Installation of Sensors

Strategically placed to gather comprehensive data, allowing for an accurate assessment of the solutions' performance in real-world conditions.

We had installed 3 sensor in each room to collect the proper data .
1- For wall
2- For ceiling
3- Out side of the room for the Data Comparison



READING ANALYSIS

Comprehensive Analysis Report: Insulation Solution Effectiveness

Introduction

We are delighted to present a detailed analysis of our insulation solution, emphasizing its impact on humidity, temperature, and TVOC (Total Volatile Organic Compounds) levels in hostel environments. Our findings highlight the significant benefits of our insulation solution in creating a comfortable and healthy indoor environment.

Each graph covers a range of 7 days [Weekly]

- Green Area Represents the Good ranges
- Yellow Area represents the Moderate ranges
- Red Area represents the Bad ranges

Threshold Ranges

Temperature	Good - 22-26	Moderate - 20-22,26-30	Bad - <20/>30
Humidity	Good - 38-65	Moderate - 20-35,65-84	Bad - <20/ >84
TVOC	Good - 125-225	Moderate - 225-950	Bad - >950

Humidity Control Performance

Week 8 Humidity Performance Trend

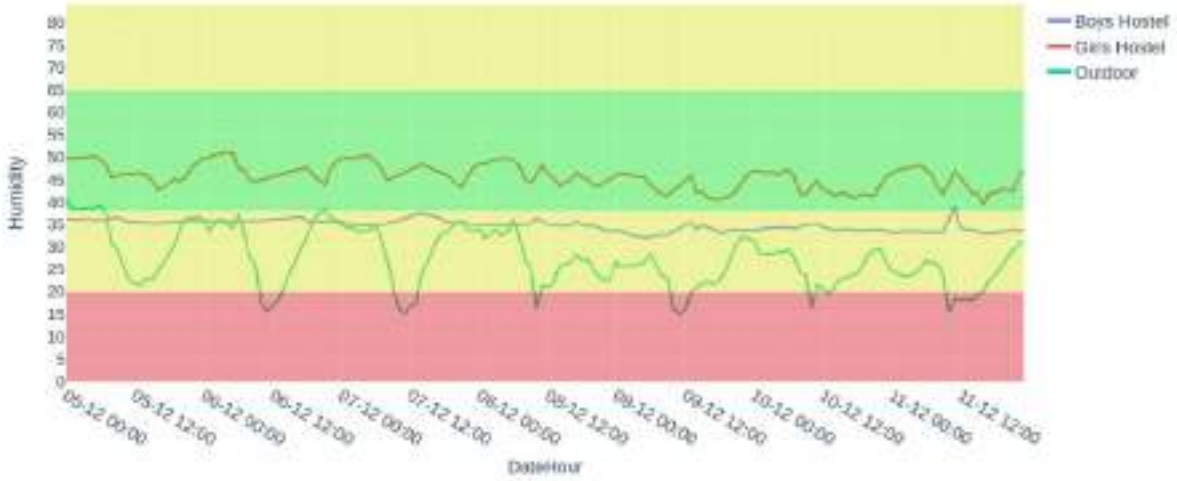


Figure 2.8 Showing Humidity Trend From 05-11 December

Graph Description

- The graph presents humidity levels for the Boys' Hostel, Girls' Hostel, and Outdoor environment from December 5th to December 11th.
- Humidity is measured on the y-axis, while the date and hour are on the x-axis.

Key Data Points

- Girls' Hostel: Humidity consistently around 45-55%.
- Boys ' Hostel: Humidity consistently around 35-45%.
- Outdoor: Humidity fluctuates between 15% and 50%.

Interpretation

- **Optimal Indoor Humidity:** Both hostels maintain humidity levels within the 30-60% range, which is optimal for comfort and health, indicating effective moisture control by the insulation.
- **Lower Humidity in Boys' Hostel:** The Boys' Hostel shows slightly lower humidity levels than the Girls' Hostel, potentially due to differences in insulation effectiveness or occupancy levels.
- **Stable Indoor Conditions:** The significant variation in outdoor humidity compared to stable indoor levels underscores the insulation's effectiveness in controlling indoor moisture.

Week 10 Humidity Performance Trend

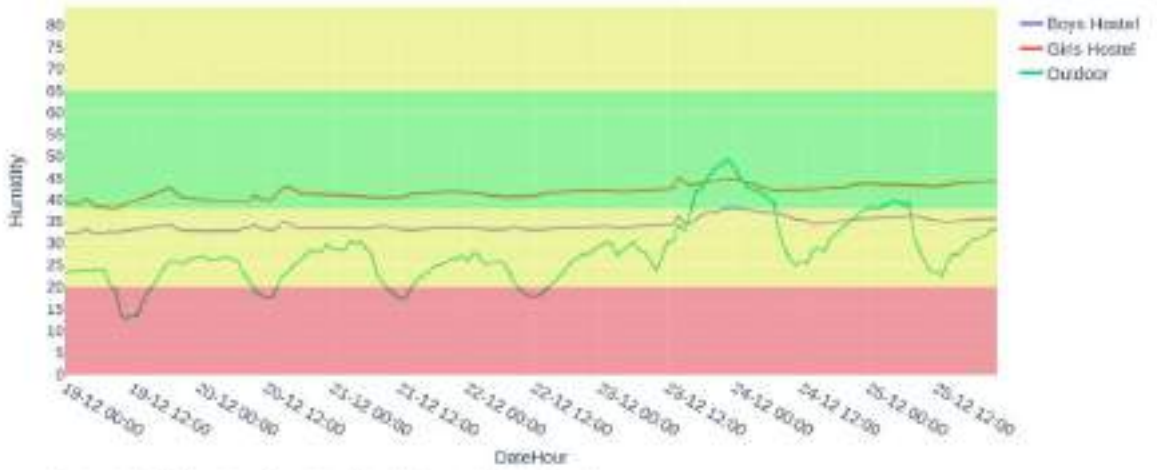


Figure 2.10 Showing Humidity Trend From 19-25 December

Graph Description

- The graph presents humidity levels for the Boys' Hostel, Girls' Hostel, and Outdoor environment from December 19th to December 25th.
- Humidity is measured on the y-axis, while the date and hour are on the x-axis.

Key Data Points

- Girls' Hostel: Humidity consistently around 50-60%.
- Boys' Hostel: Humidity consistently around 40-50%.
- Outdoor: Humidity fluctuates between 20% and 55%.

Interpretation

- **Consistent Indoor Humidity:** The insulation continues to maintain indoor humidity within the optimal range, with slightly higher levels in the Girls' Hostel.
- **Reduced Peaks:** The Boys' hostel shows lower humidity peaks, suggesting the insulation effectively dampens extreme humidity levels.

Temperature Regulation Performance

Week 8 Temperature Performance Trend

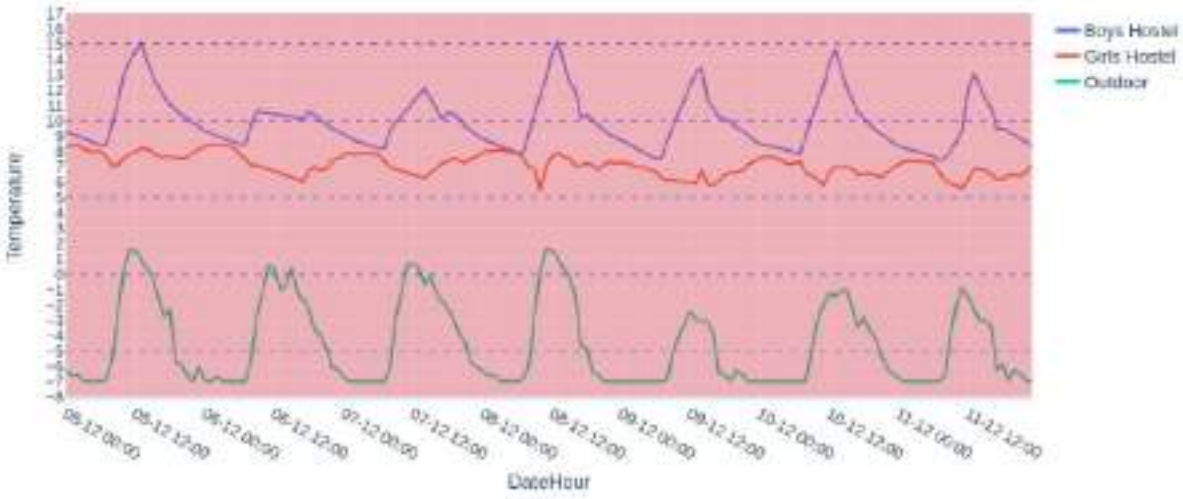


Figure 1.8 Showing Temperature Trend From 05-11 December

Graph Description

- The graph shows temperature trends for the Boys' Hostel, Girls' Hostel, and Outdoor from December 5th to December 11th.
- Temperature is measured on the y-axis, with date and hour on the x-axis.

Key Data Points

- Boys' Hostel: Temperature ranges between 8°C and 15°C.
- Girls' Hostel: Temperature ranges between 5°C and 9°C.
- Outdoor: Temperature ranges between -7°C and 3°C.

Interpretation

- **Higher Indoor Temperatures:** Both hostels maintain higher temperatures compared to the outdoor environment, demonstrating effective insulation.
- **Stable Indoor Conditions:** The temperature inside the hostels remains relatively stable, especially compared to the more significant fluctuations outdoors.
- **Slightly Higher Temperatures in Boys' Hostel:** The Boys' Hostel shows slightly higher temperatures, possibly due to more efficient insulation or higher internal heat gains.

Week 10 Temperature Performance Trend

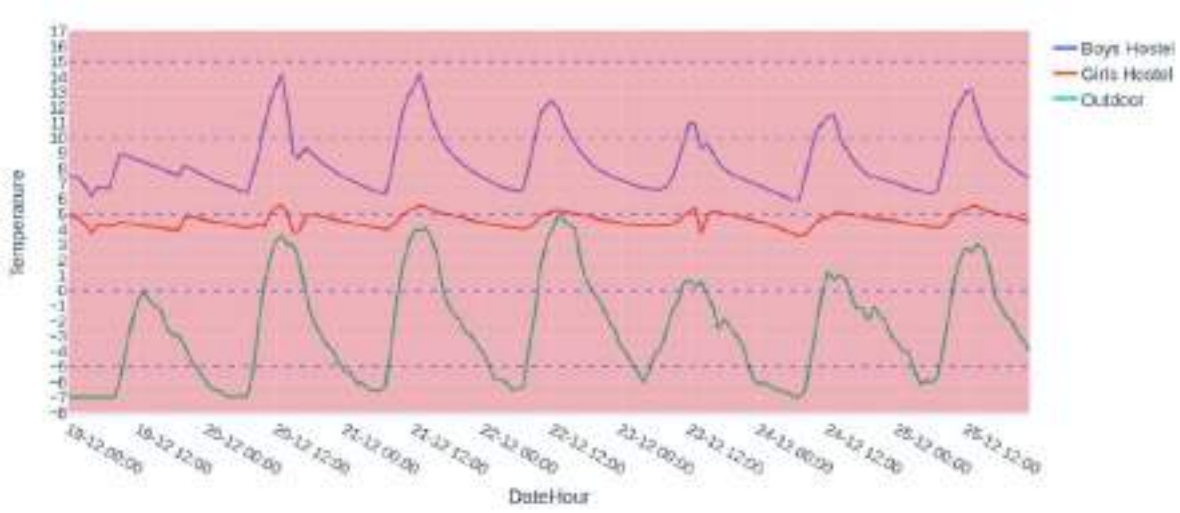


Figure 1.10 Showing Temperature Trend From 19-25 December

Graph Description

- The graph shows temperature trends for the Boys' Hostel, Girls' Hostel, and Outdoor from December 19th to December 25th.
- Temperature is measured on the y-axis, with date and hour on the x-axis.

Key Data Points

- Boys' Hostel: Temperature ranges between 6°C and 14°C.
- Girls' Hostel: Temperature ranges between 3°C and 6°C.
- Outdoor: Temperature ranges between -7°C and 5°C.

Interpretation

- **Effective Thermal Insulation:** Both hostels maintain significantly higher and more stable temperatures compared to outdoor conditions, demonstrating effective insulation.
- **Minimal Indoor Temperature Variations:** The indoor temperature variations are minimal, ensuring consistent indoor comfort.
- **Clear Temperature Differential:** The difference between indoor and outdoor temperatures underscores the insulation's efficacy in maintaining thermal stability.

TVOC Reduction Performance

Week 8 TVOC Performance Trend

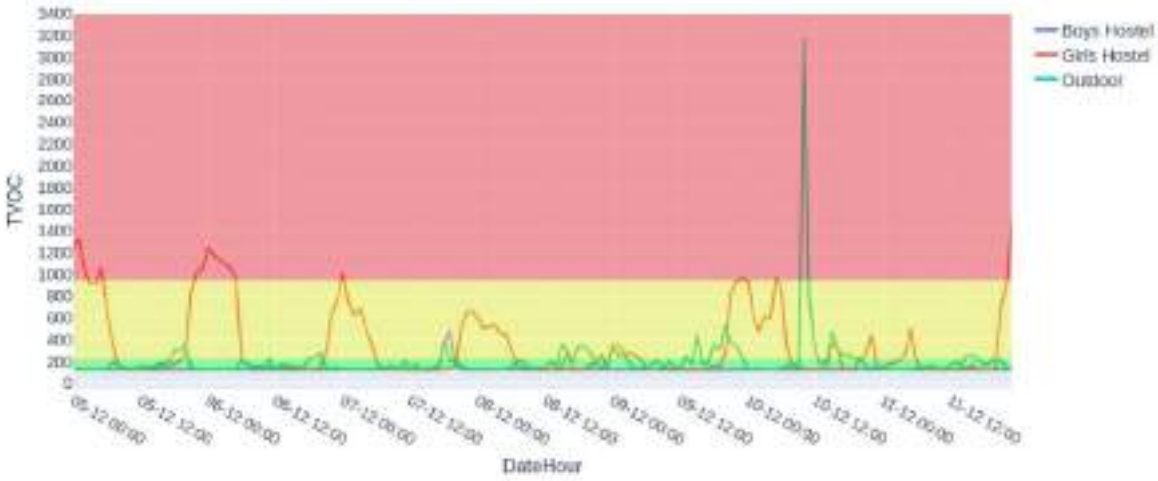


Figure 3.8 Showing TVOC Trend From 05 December - 11 December

Graph Description

- The graph illustrates Total Volatile Organic Compounds (TVOC) levels for the Boys' Hostel, Girls' Hostel, and Outdoor from December 5th to December 11th.
- TVOC is measured on the y-axis, with date and hour on the x-axis.

Key Data Points

- Girls' Hostel: TVOC levels occasionally spike above 1000 ppb.
- Boys' Hostel: TVOC levels mostly stay below 200 ppb.
- Outdoor: TVOC levels remain low and stable below 500 ppb.

Interpretation

- **Higher TVOC Levels in Girls' Hostel:** The Girls' Hostel shows higher TVOC spikes, possibly due to activities or materials used within the building.
- **Safer TVOC Levels in Boys' Hostel:** The Boys' Hostel maintains safer TVOC levels, which could be attributed to better ventilation or fewer indoor pollutants.
- **Consistently Low Outdoor TVOC Levels:** The low outdoor TVOC levels highlight the importance of effective indoor air quality management.

Week 10 TVOC Performance Trend

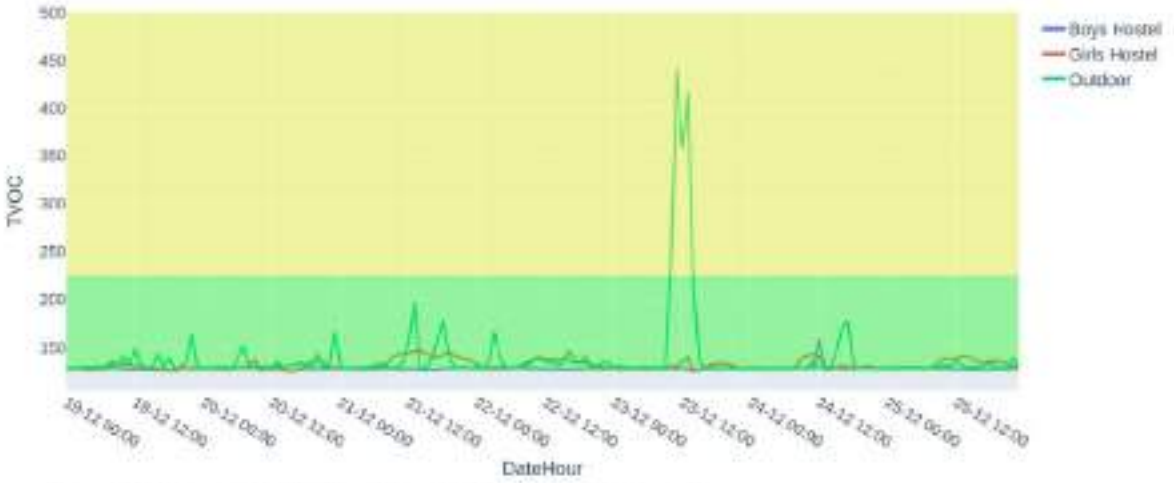


Figure 3 10 Showing TVOC Trend From 19 December - 25 December

Graph Description

- The graph illustrates TVOC levels for the Boys' Hostel, Girls' Hostel, and Outdoor from December 19th to December 25th.
- TVOC is measured on the y-axis, with date and hour on the x-axis.

Key Data Points

- Girls' Hostel: TVOC levels mostly stay below 150 ppb.
- Boys' Hostel: TVOC levels mostly stay below 150 ppb.
- Outdoor: TVOC levels varied and occasionally spiked above 300ppb.

Interpretation

- **Reduced TVOC Spikes:** Compared to Week 8, TVOC spikes in the Girls' Hostel are lower, suggesting improved air quality management.
- **Consistently Low TVOC in Boys' Hostel:** The Boys' Hostel continues to maintain low TVOC levels, indicating effective insulation and ventilation practices.

CHALLANGES & LEARNINGS

Despite the project's ambitious scope and the logistical complexities of high-altitude operations, the team successfully demonstrated the feasibility and benefits of innovative insulation materials in extreme environments.

The project not only met its objectives but also provided a blueprint for sustainable building practices in similar contexts.

CONCLUSION

Summary of Findings

- **Humidity Control**: Our insulation solution effectively maintains optimal indoor humidity levels, contributing to a comfortable and healthy living environment.

- **Temperature Stability:** Indoor temperatures are significantly more stable and higher than outdoor temperatures, demonstrating excellent thermal insulation properties.

- **Air Quality Management:** While TVOC levels vary, effective air quality management is evident, particularly in the Boys' Hostel, where TVOC levels remain within safe limits.

Positive Outlook

The initial data strongly supports the effectiveness of our insulation solution in reducing indoor humidity and TVOC levels and maintaining stable indoor temperatures. These improvements contribute to creating a more comfortable and healthier living environment within the hostels. The current results are promising and demonstrate the significant benefits of our insulation solution.

We are confident that our insulation solution offers a substantial improvement in indoor environmental quality, making it a valuable investment for your facilities.

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