

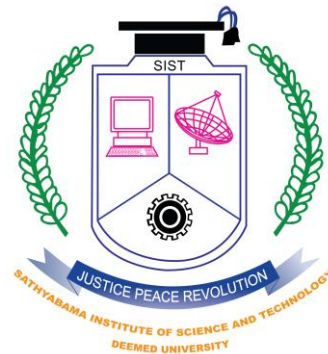
ANALYSE THE PERFORMANCE OF AN ECO-TOURISM RESORT IN A REGENERATIVE ENVIRONMENT

A Thesis

Submitted in partial fulfillment of the requirements for the award of
Master of Architecture degree in Sustainable Architecture

by

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**DEPARTMENT OF ARCHITECTURE
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **S GANESH RAJAN (39890007)** who carried out the Thesis entitled "**ANALYSE THE PERFORMANCE OF AN ECO-TOURISM RESORT IN A REGENERATIVE ENVIRONMENT**" under our supervision from January 2021 to May 2021.

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ABSTRACT

Regenerative architecture is a term that is framed in the late 21st century to ensure a positive outcome from existing sustainable practice. In today's trend construction industry plays a major role in carbon emissions, water consumption, waste production which can cause various environmental issues. These kind of buildings that are not optimised in energy consumption can be named as vacuum buildings which inherit a trait of exploiting ecological state. So, to preserve the ecological state of a region only sustainable practice which reduces the impacts on environment is not enough but a style that breathes life and restores the lost habitat is required. The term regenerative refers to a process that repairs, recreates and restores its own source of energy. So, the objective of this research is to create a regenerative environment that produces a net positive output by creating series of complete loops for consumed materials and balancing them by creation of products or from by-products.

The flow of this research focuses on restoring the equilibrium between nature and man-made structures. For this to happen it is necessary to understand the parameters of Regenerative design and how it influences the energy, water, material used over the environment. Analysis is done based upon case studies to understand the form, orientation, design elements etc. Qualitative study relating producing questionnaires, research paper study and Internet study will be done to understand the context of regenerative architecture. Quantitative details such as Water calculations, Electricity calculation, Food waste, Rainwater calculation and environmental simulations will be carried out. So the selected site will be incorporated with all the mentioned study to conclude with the design.

So, to conclude this will be a qualitative approach which focus more on design elements to improve the quality of lifestyle of people and ecology within the site.

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LIST OF SYMBOLS AND ABBREVIATIONS

T_a	-	Air Temperature
T_{mrt}	-	Mean Radiant Temperature
V	-	Wind Speed
RH	-	Relative humidity
PET	-	Physiological equivalent temperature
SVF	-	Sky view factor
U value	-	Thermal Transmittance
R value	-	Thermal Resistance
CSEB	-	Compressed Stabilized Earth Blocks

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Regenerative design is about thinking ahead, where one must design with the future in mind. It contradicts with sustainably designed buildings, which are based on the concept of only using the minimum resources you need, regenerative buildings are designed and operated to reverse damage and have a net-positive impact on the environment.

Buildings as trees, and cities as forests propose an evolution of modernist architecture paradigms from mechanical to organic and that changes everything where architecture is designed through regenerative processes that mimic ecological interrelationship.

At the macro scale, regenerative buildings can serve as a carbon substation sites which can generate and store energy on site for surrounding communities, can use the site to clean storm water runoff, and can even have skins that 'scrub' the air. This idea is not just using fewer resources, but of replenishing and bettering our environment.

A community could learn a great deal from the forest and the ultimate technology of cooperation, networking, diversity, high technology, self-organization. The energy is produced by water distribution, photosynthesis, efficient communication, not generating waste etc. we are talking about a regenerative system in all dimensions, the "law of the jungle" in partnership.

1.2 AIM

The aim of this thesis is to create an Eco resort that is built entirely with natural materials and thereby interact with the site to Regenerate its resources for it to self-sustain.

1.3 RESEARCH QUESTIONS IDENTIFIED

- How can Architecture help in Regenerative Environment design for a Community?
- What are the feasibility aspects of Permaculture Architecture inside a Community?
- How does a Circular Economy work within a community?

1.4 OBJECTIVES

- To Design a structure from natural Materials to reduce the impact on the environment.
- To Study the state of architecture and how it helps to regenerate a piece of land.
- To validate how effective a circular Economy functions within the site.

1.5 THE NEED FOR REGENERATIVE ENVIRONMENT

In Today's construction Practice there is a lot of deviation with man-made and ecological co-existence which is an essential parameter for life to co-exist. The challenge of environmental architecture is to meet the current demands of people and thereby damping the impacts on ecology. The world has encountered a rise in industrial and technological advancements at a rapid phase which lead to the increase in demand to cope up the population boom and therefore causing an inflation on construction field which let the environmental impacts left unchecked in the past 2 decades.

Frank Lloyd Wright an innovator in terms of eco sensitive buildings even before the term "ECOLOGY" was coined and used. He had a belief that a building must live in harmony with its environment and therefore it is achieved by technological material selection and understanding social aesthetic aspect. An Ecologically sensible designer must design with a different approach such as aesthetic, economical social and ecological sense that replaces the human domination over natural world. And a building that does not come up with all

these parameters is considered as a vacuum design. To Maintain an ecological integrity, the architect must have a thorough understanding of the local eco systems which includes climate, flora, fauna, materials, soil type, water flow, biotic communities, and critical habitat at-risk species Eco Friendly Buildings is a mixture of passive design to reduce energy, bio mimicry, net zero, locally available materials, vernacular architecture and giving way to ecological sustainability.

The Research Paper “THE ECO-FRIENDLY BUILDINGS- A ARCHITECTS PERSPECTIVE by Akanu Ibiam” generally focused on the impacts of vacuum buildings on environment and suggestions were given on how to improve in theoretical format. Environmental Sustainability at a global state is considered as impossible in today’s Context due to the huge requirement of landscape. And How much impact can this design reinvent natural coexistence. Due to the over consumption of fossil fuels by vacuum buildings at a rapid phase it is a necessary step to also research on eco-friendly buildings which promises on reducing the natural impact over environment.

So in analyzing with this research paper, we can see that there are **many loop holes** by which environment gets affected. The author coins the word **“Vacuum Buildings”** to signify the **importance of ecologically sensible buildings** that are sustainable in nature. He also adds the point that **over consumption of fossil fuels** at a rapid phase is a necessary step to **research on ecofriendly buildings** which promises on **reducing natural impact on environment**.

1.6 SCOPE OF THE PROJECT

- The Project will Try to implement Permaculture within the site boundary which is a key participant in Regenerative Designs.
- Will be Constructed using Locally available materials and Natural Materials which can be gathered around the site.
- Cost Analysis will be made based on the materials that was used for construction.

- Regenerative Aspects will be incorporated for Water and Energy resources that are within the site.

1.7 LIMITATIONS OF THE PROJECT

- The structural height of any building within the site is only at ground level.
- Cradle to Cradle process and implementation of any material or resource is studied only within the site.
- Ecological Footprint calculation will not be done for the Project.

1.8 VISION OF THE PROJECT

To create a symbiotic environment that is sustainable in nature, self-resilient, supports humans and respects eco system which in-turn regenerates itself to help in restoring the damaged equilibrium.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Regenerative design relates to approaches the co evolution of humans as well as natural systems in a partnered relationship. It can be better explained in a sense that the building takes the role of a catalyst in self-healing and self-organizing of living beings without compromising on ecology. With Regenerative design, built projects and inhabitants are collectively focused on enhancing life of humans, other species and ecological systems maintaining an equilibrium and thereby without affecting the biodiversity of a specific system. It is also a process in which net positive output is derived which includes, energy water and air without over consumption and thereby having reduced impacts on environment. Net positive outputs can only be Framed if the output of building ranges from 105% - 110% of the total intake inside the site and all this must happen within the site so excessive outputs can be stored and used later as a backup.

A Regenerative building not only restores but also improves the surrounding environment by enhancing the biotic and abiotic components of the environment. This technique requires the designer to think from site, water, climate, energy, flora, fauna, microbes, human social system and culture. Carbon is seen as the main enemy in pollution since we break its cycle which is considered as a design failure. Regenerative design can be achieved by utilizing carbon free technologies, producing net positive outputs, urban agricultures such as food on green roofs, local animal farming and raising fish on ponds. Recharging storm water to nearby ponds or self-developed ponds, constructed wetlands, and creating local ecosystems for species who lost their habitat.

J.T. Gibberd argued “a building is an element set within wider human endeavors and is necessarily dependent on this context. Thus, a building can support sustainable patterns of living, but in and of itself cannot be sustainable” Regenerative design goes a step further than sustainable design. In a regenerative system, feedback loops allow for adaptability, dynamism and emergence to create and develop resilient and flourishing eco-systems. Cole highlights a key distinction of regenerative design is the recognition and emphasis of the “co-evolutionary,

partnered relationship between human and natural systems” and thus importance of project location and place. Bruno Duarte Dias asserts that regenerative design goes beyond the traditional weighing and measuring of various environmental, social and economic impacts of sustainable design and instead focuses on mapping relationships. Dias is in agreement with Cole stating three fundamental aspects of regenerative design which include: understanding place and its unique patterns, designing for harmony within place, and co-evolution.

2.2 ELEMENTS OF REGENERATIVE ENVIRONMENT

To design human and ecological systems, the Designers use applied permaculture design principles, systems thinking, and community development processes. The biomimicry, circular economics, biophilic design, ecological economics, considerably influence the development of regenerative design and also social movements such as transition, permaculture, and the new economy. The process of designing systems such as restorative justice, rewilding and regenerative agriculture can be referred to Regenerative design.

Integrated design Thinking – Site, Material and Waste, Water, Energy, Human health and Happiness, Equity and Beauty

- Energy Consumption and Saving Measures
- Sustainable site Developments
- Reduced Carbon footprint
- Net positive output in buildings
- Nature and Manmade Structure Symbiosis
- Increasing Bio Diversity
- Creating suitable Habitat for lost eco system
- Circular Economy
- Permaculture Architectural Designing

Over these elements Circular Economy, Permaculture design, Habitat for lost eco systems, Increase in bio diversity, Environmental symbiosis shows the variation of regenerative design from conventional sustainable practices. Circular economy and Permaculture are the most influential over the others as they promote regenerative aspects in a large scale.

2.2.1 Integrated Design Thinking:

- Involves in considering **Site, Material and Waste, Water, Energy, Human health and Happiness, Equity and Beauty as a whole** and combining them into a **single design process**.
- This ensures that the building gets constructed in an **efficient way without the usage of excess energy**.
- For Example, when we consider site planning we must look into excavation, replacement of lost ecology, reusing of excess soil within the site, transportation, construction and demolition waste, energy required for transport etc. to make the site efficient.

2.2.2 Energy Consumption and Saving Measures:

- Energy consumption within a selected area of study, effective measures **to create or recreate lost energy** to get things into **cycle**.
- Role of **energy efficient hardware** can save a lot of energy.
- For example, use of LED bulbs as it tends to emit more luminance with lesser watts.

2.2.3 Sustainable Site Developments:

- Things such as **trees, ecology, water flow pattern, soil type, habitat at risk** all comes under this. This also comes under Integrated design

thinking process but here it specifically focuses more on **how the site interacts with the environment**.

- This is considered because a collection of sites give way in forming a community so it is necessary we look into each and every site of location.

2.2.4 Reduced Carbon Footprint:

- Reduction in overall carbon foot print can produce **more sustainable and efficient building systems**. A Less power consuming settlement can lead to **Lesser urban heat islands**.
- Overall it helps the settlement go sustainable and **cause lesser environmental issues**.

2.2.5 Net positive Output in Buildings:

- Energy consumption within a selected building can produce excess energy that can be **shared with the central power grid** for that local area, this local source can thereby **reduce the overall energy required** for the entire community.
- This promotes a whole **community regenerative power source**.

2.2.6 Nature and Man Made Structure Symbiosis:

- Design and **construction of structures in an organic method** in such a way that it does not affect the natural ecosystem surrounding the man-made structure.
- Elements such as **Bio degradable, non-toxic, non-hazardous can help in environmental symbiosis**.

2.2.7 Increasing Bio diversity:

- Natural symbiosis helps to **trigger bio diversity in eco system**. Since man operates as an **equilibrium with the nature** there is a scope for a **rich eco system**.

- An increase in Bio-diversity signifies that the Community is towards **the path to regeneration**.

2.2.8 Creating Habitat for Lost Ecosystem:

- **Repairing existing resource** which are **damaged, encroached, contaminated to support local ecosystem** to improve **bio diversity** in a specific region.
- For example, use of constructed wetlands can improve eco system of that specific region as well as clean the contaminated water present in a lake.

2.2.9 Permaculture Architectural Designing

- Permaculture design emphasizes patterns of landscape, function, and species assemblies. It determines where these elements should be placed so they can provide maximum benefit to the local environment.
- Permaculture maximizes useful connections between components and synergy of the final design.
- The focus of permaculture, therefore, is not on each separate element, but rather on the relationships created among elements by the way they are placed together, the whole becomes greater than the sum of its parts.

2.2.10 Circular Economy

- A circular economy is defined as an economic system of closed loops in which products, raw materials and components lose their value as little as possible, renewable energy sources are used and systems thinking is at the core.
- It aims to keep products, equipment and infrastructure in use for longer, thus improving the productivity of these resources. All "waste" should become "food" for another process: either a by-product or recovered resource for another industrial process or as regenerative resources for nature.

Over these elements **Circular Economy, Permaculture design, Habitat for lost eco systems, Increase in bio diversity, Environmental symbiosis** shows the variation of regenerative design from conventional sustainable practices. Circular economy and Permaculture are the most influential over the others as they promote regenerative aspects in a large scale.

2.3 CIRCULAR ECONOMY

From the beginning of the 20th there has been various iterations of building construction has shaped sustainability in such a way as how it is existing today. Bio Climatic architecture (1908-1968), Environmental architecture (1969-1972), Energy conscious architecture (1973-1983), Sustainable Architecture (1984-1993), Green architecture (1994-2006), Carbon Neutral Architecture (2006-2015) and Finally Regenerative Architecture (2016- Future). For the upcoming 20 years the verse of the 7th Paradigm named regenerative architecture will be influenced by ideas of Lyle, Braungart and McDonough regarding cradle to cradle design and Bio Mimicry. The influence of these 7 paradigms has sculpted the architectural practice in a way that encouraged new construction techniques such as insulation materials, renewable system, efficient HVAC technologies. The most recent trend is ultra-efficiency and effectiveness.

Buildings are Responsible for 40% of carbon emission, 14% of water consumption, 60% of waste production and 50% of the world's population is in urban areas. The building construction and urban sprawl severely damage the Environment that it destroys agricultural lands, wetlands or even water bodies present in its way which the earth cannot compensate. Building Materials are another limited resource within a building life cycle. The regenerative nature of most materials used is also long since they were subjected to millions of years in making. Even the Net Zero building concept that seeks to accomplish max efficiency from the notion of neutralizing the resource consumption restricts a building's impact to "zero" or "net zero" which is misguided to a long term sustainable building practices.

In order to achieve a positive building foot print, we need to move from cradle to grave paradigm which supports reduce, avoid, prevent fossil fuel energy use to a regenerative paradigm that aims to increase, support, and optimize the use of

renewable energy resources. A regenerative sustainable building seeks the highest efficiency in managing combined resources and max. generation of renewable resources.

The term “Regenerative” refers to process that repairs, recreates or revitalizes its own source of energy. In a sustainable society it shapes the needs of community, its needs and its balance of nature. Thus, the concept of regeneration occurs by creating a series of circle of consumed materials is balanced by creation of products or by-products. Applied to architecture a building will integrate a number of constrains inside its loop and there by on a whole it will be able to reproduce and recreate all of its resources it consumed to be rebuilt to perform and function. Safe and Healthy materials, Material Reuse, Renewable energy and Carbon Management, Water Stewardship, Social Fairness are the necessary framework that needs to be addressed at conceptual stage while designing a regenerative building.

Selection of construction system, defining of design elements and their performance, enhance air quality and human health, energy saving, renewable energy production, water management, designing with nature, choice of regenerative materials to be used are some design criteria to be followed while formulating a design idea.

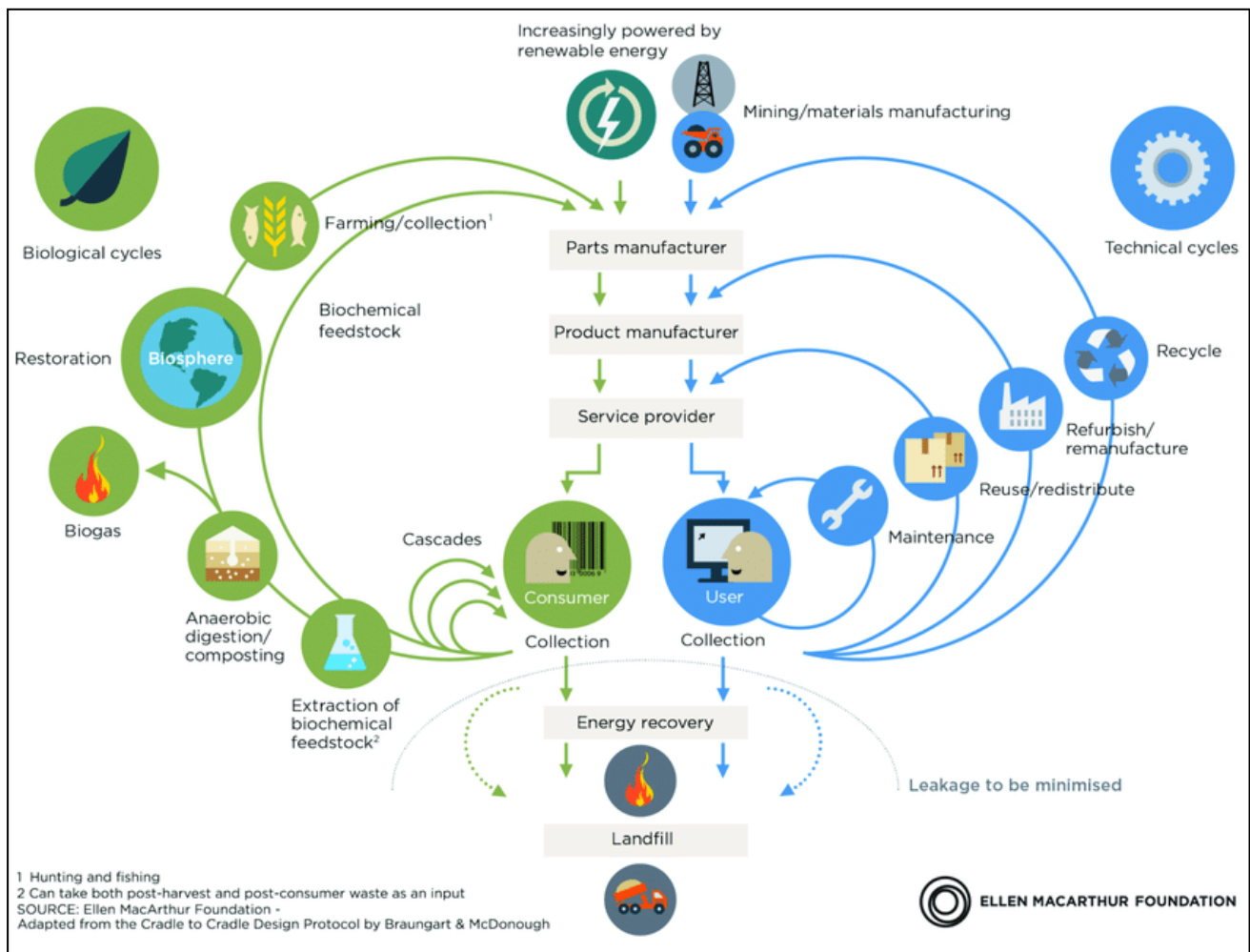


Fig 2.1 A Diagram depicting a typical circular economy

2.3.1 PRINCIPLES OF CIRCULAR ECONOMY

A Circular Economy is Looking beyond current existing model. A Circular model economy aims to refine growth, focusing on positivity and society vice benefits.



Fig 2.2 A Diagram of cradle to grave system

The 3 Principles of a circular Economy include,

- Design out waste & pollution
- Keep products & material in use
- Regenerative natural system.

A Circular Economy builds & Rebuilds the overall system health there are 4 stages of circular economy which includes,

- Purchase of resource
- Usage of Resource
- Repurposing of used resource
- Redistribution of used resource

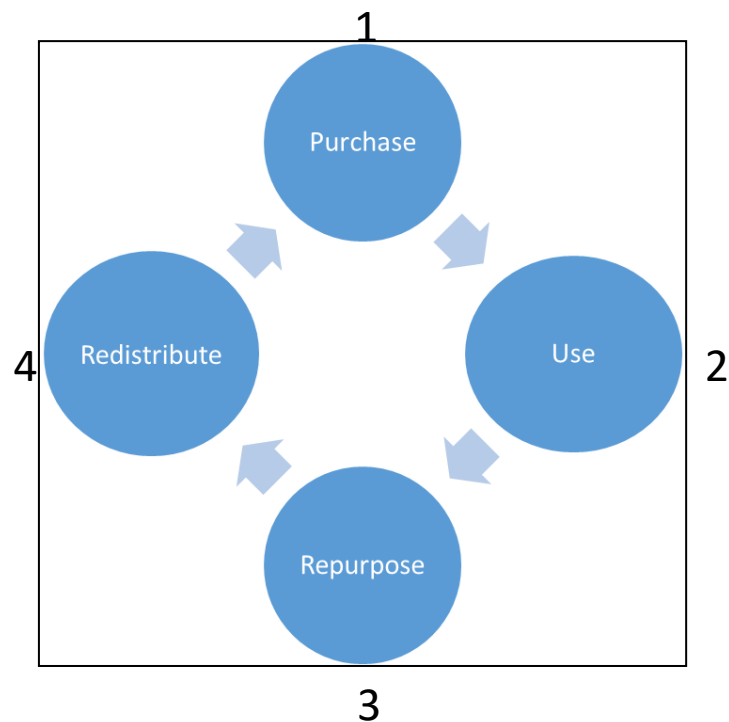


Fig 2.3 A Diagram of cradle to cradle system. (Circular Economy)

1) Purchase:

- Circular economy starts with purchase.
- Anything that undergoes a circular lifestyle is designated for disassembly.
- E.g. Consumer purchase recycled metals, plastic for energy purpose and irrigation system buys recycled water.

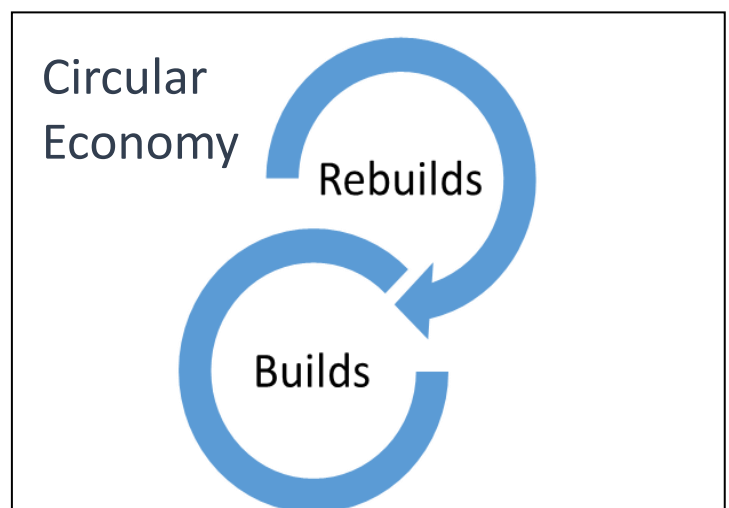


Fig 2.4 A Diagram of Circular Economy

Use:

- Materials in circular economy don't just age as time passes by, they get consumed for what they are designated to offer.
- This must not only be a resident level but also at an industrial level so that it makes sure that we deplete a resource before discarding it.
- E.g., Refineries use sulfuric acid to produce alkylate, a compound in gasoline that is used to improve fuel efficiency. Partner companies such as Veolia reclaim this spent acid and regenerate it back into the original state to make more alkylate.

2) Repurpose:

- This process gives resources another life.
- This process may not have the same product but a by-product which can be repurposed.
- E.g., Combined Heat and Power plants generate and form green steam that makes affordable, low carbon alternative to independent heating systems in buildings.

3) Redistribution:

- It is critical to make a circular solution sustainable end to end.
- Communities need a way to capture the repurposed product and deliver it to the next consumer.
- E.g., A town's garbage collector can team up with manufacturers like plastic, metal, paper, glass so that redistribution occurs

2.4 PERMACULTURE ARCHITECTURE

David Holmgren and Bill Mollison devised the word permaculture in 1978. The original meaning of the word permaculture is to refer "permanent agriculture", but was expanded to stand also for "permanent culture", as it was understood. As Masanobu Fukuoka's natural farming philosophy inspired, the social aspects were integral to a truly sustainable system and the Regenerative design is integral to permaculture design.

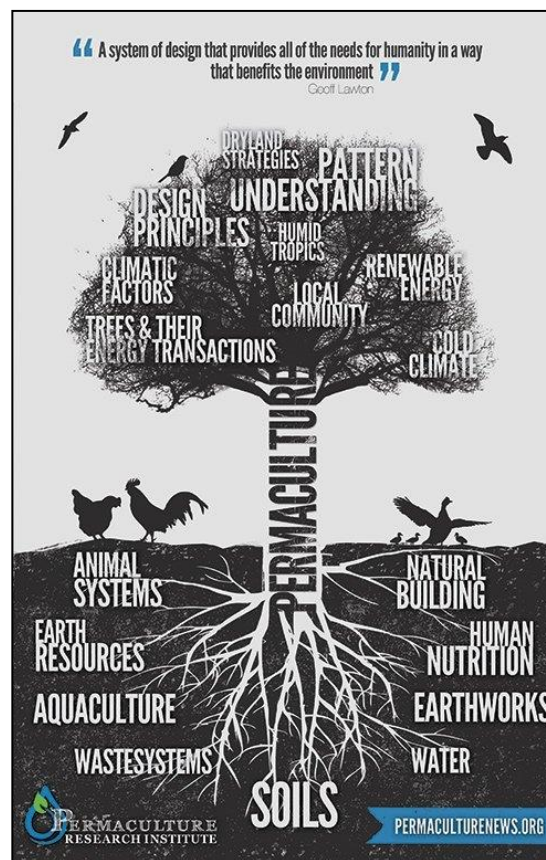


Fig 2.5 A Diagram of Permaculture

Robert Rodale coined the term 'regenerative organic agriculture'. The term defined a type of farming that is more than 'sustainable'. To regenerate when disturbed, the Regenerative organic agriculture "takes advantage of the natural tendencies of ecosystems. In that perspective, it is differentiated from other forms of agriculture that may be either against or ignore the results of those natural tendencies". This kind of farming is defined by "tendencies towards greater diversity

in the biological community, greater reliance on internal rather than external resources, more perennials and fewer annuals, and closed nutrient loops."

John T. Lyle (1934–1998), a landscape architecture professor observed the relation between concepts developed by Bob Rodale for regenerative agriculture and the chances to develop regenerative systems for all other aspects of the world. While regenerative agriculture focused solely on agriculture, Lyle expanded its concepts and use to all systems. Lyle understood that when developing for other types of systems, more complicated ideas such as entropy and energy must be taken into consideration.

Permaculture is a way to integrate Land, resources, people and mutually beneficial strategies that initiates no waste closed loop system as seen in natural systems. It is said that permaculture can provide solutions for rural as well as urban context at any scale. It is a multi-disciplinary technique that involves agriculture, water harvesting, energy, natural buildings, hydrology, forestry, waste management, animal systems, aquaculture, technology and community development. It is a integration of landscape and people in providing people with food, energy, place for living and material needs in a sustainable way with harmony.

Permaculture design is basically a multi-faceted and fully integrated and environmentally harmonious method for defining designs for human-focused landscapes. The permaculture design environment will be capable of providing many essential necessities of a family unit or a community efficiently and with use of principles of sustainability. In integrated design, efforts are centered on inter-linking all elements in a system by successful arrangement of the outputs of one entity to the inputs of a second entity with more efficiency and zero waste.

The Permaculture design works also with natural harmonies to revitalize poor yielding lands and construct natural systems to support human beings living on the earth. There are many different disciplines included in Permaculture, such as hydrology, soil science, biology, engineering, geography, climate, geology and architecture. The Permaculture designers are considered to be generalists possessing basic understanding of many disciplines and their practical use and relevance. This perspective enables these generalist designers to envision a broad, comprehensive view, or meta-picture of a large, interconnected network or system.

2.4.1 HOW PERMACULTURE DESIGN IS RELATED TO ARCHITECTURAL PLANNING

Permaculture design has a basic connection to architectural planning and design because it is focused on the following essential design elements:

- **Mainframe Design:**

Mainframe design is often the starting point for Permaculture designs projects as it validates all dimensions of the big picture. The mainframe consists of study and designs for the essential characteristics of a future human landscape. The essential characteristics are water, structures and access. In Permaculture design, emphasis is given to optimize our interactions with water when it traverses through the landscape with the essential functions of slow, sink and spread.

The fundamental rules for access design are traveling a landscape on contour when possible, crossing valleys along dam or pond walls whenever feasible and to avoid erosion, descending or ascending landscapes following ridge lines. In terms of structure, by allowing the pattern of a physical site to rule, we will have a well-situated, efficient and effective dwelling in harmony with nature.

- **Sector Analysis:**

Sector analysis is done with the current of steady incoming energies to the site, that cannot be avoided. This is due to that the are exterior energies do not originate and they are not controlled onsite.

- **Zone Planning:**

Zone planning makes use of a location-related approach to elements that we may desire to include in a Permaculture design. It is not merely a manner of approaching and studying energy needs of components for proper placement in proximity to major habitation areas of the overall design, but requires a creative style of placement as well as scientific considerations. These zones are not fixed.

- **Workflows:**

Workflows, or “life flows,” are important design aspects of creating an entire lifestyle, or Permaculture design. Designing for workflows entails using an imaginative viewpoint to envision how we might interact with this newly created site on a daily, monthly or yearly schedule.

- **Analysing and Connecting Components:**

Analysis and interlinking of components comprises of noting all of the requirements and products or functions of each component of a system. By this activity, we can easily comprehend how various components may interact so that we may begin to envision the connecting of these components to form a “holistic” design that is functionally integrated.

2.4.2 PRINCIPLES OF PERMACULTURE ARCHITECTURE

The 12 permaculture design principles include thinking tools, that when combined together, help us to creatively re-design our environment and our nature in a world of less resources and energy. These principles are universal, although the methods used to express them will vary greatly according to the situation and place. They can be applied to our social, personal, economic and political reorganization. The ethical foundation of permaculture supports the use of these design tools, assuring that they are utilized in appropriate ways. Each principle can be considered as a door that opens into a whole system of thinking. They provide a different perspective that can be understood at varying levels of depth and application. David Holmgren, the co-originator of permaculture, redefined permaculture principles in his seminal book, *Permaculture: Principles and Pathways Beyond Sustainability*. When I started giving talks about permaculture to all sorts of different audiences, I decided to write my own explanations and apply the principle not only to designing gardens and farms but to business, society and culture. Every principle comes with David's 'proverb' and is followed by an explanation.

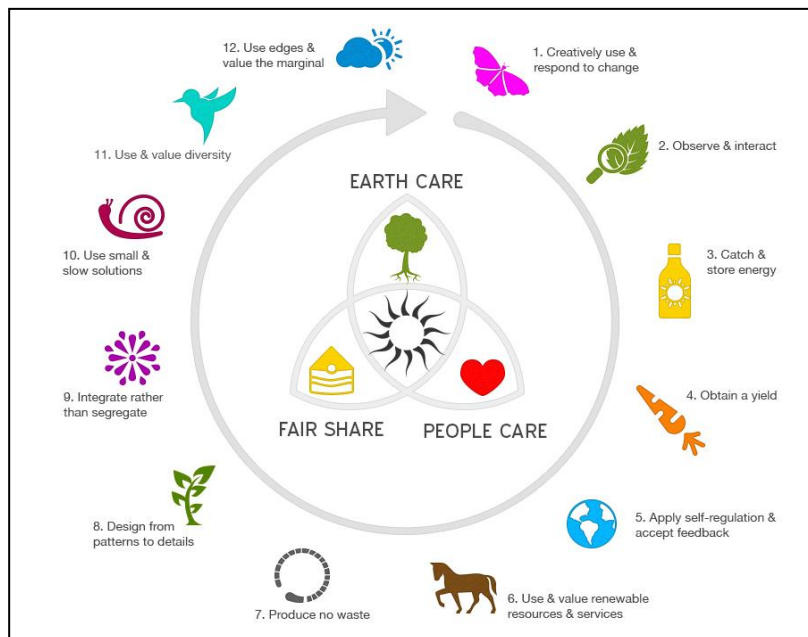


Fig 2.6 A Diagram of Principles of Permaculture

1. Observe and interact
2. Catch and store energy
3. Obtain a yield
4. Apply self-regulation and accept feedback
5. Use and value renewable resources and services
6. Produce no waste
7. Design from patterns to details
8. Integrate rather than segregate
9. Use small and slow solutions
10. Use and value diversity
11. Use edges and value the marginal
12. Creatively use and respond to change

- **OBSERVE AND INTERACT:**

“Beauty is in the mind of the beholder”

The element of observation and stillness constructs the basis of permaculture design. This is a world of instant makeovers, where every-thing is fast, having the ability to observe the seasons, monitor the changing micro climates on a piece of land, to understand how the patterns of wind, weather and slope affect the frost pockets and plant growth, is a chance to learn the major aspects of Earth Care. It also makes us more capable of making wise decisions about how we design or eco-renovate our houses and plan our gardens and farms.

- **CATCH AND STORE ENERGY:**

“Make hay while the sun shines”

Closely connected to observation is the art of capturing energy in a design, so that we can reduce the need to acquire resources from the outside. In a garden this is like excluding planting young seedlings in frost pockets in spring or increasing the solar energy, and it can be achieved by either a conservatory or a greenhouse. By this approach, we are trying to retain the resources like heat, water, sunlight, biomass, fertility and soil. This will make us more self-supportive. So, we can extend the season and increase the heat in a house with passive solar gain.

- **OBTAIN A YIELD:**

“You can’t work on an empty stomach”

Food is so important as much as one third of our ecological footprint. Hence it makes sense to grow as much as possible, even if this is constraint to the sprouted grains on the windowsill of an apartment. So a permaculture garden is an edible landscape accompanied with good floral plants. This will attract beneficial insects, and a building is a potential heat store and structure for solar panels. But the concept of 'yields' is not merely about renewable energy or veggies; it can be a social capital. It is good to see people changing their lives for the better, building community links and reducing their carbon.

- **APPLY SELF REGULATION AND ACCEPT FEEDBACK:**

“The sins of the fathers are visited on the children of the seventh generation”

When the fossil fuels are burnt, CO₂ is released into the atmosphere. This will trap the heat and increase the temperatures on the planet surface. This causes ice to melt which leads to loss of reflective surfaces, leading to more absorption of sunlight and even higher temperatures. We must accept responsibility for our actions.

- **USE AND VALUE RENEWABLE RESOURCES AND SERVICES:**

“Let nature take its course”

Whenever possible, permaculture tries to utilize the renewable resources. This is not only applicable to energy but also to soil conservation, coppicing, ecological building and the planting of annual food crops, as well as perennials with seed saving. The dangers of relying on non-renewables, technological fixes and speculative money are becoming ever more evident.

- **PRODUCE NO WASTE:**

“Waste not, want not”

In the UK, the equivalent of 24 bags of sugar per household per week are to be thrown away. 14.1 kg per week is equal to 29 million tons per year approximately. There is a favourite saying that the landfill of today will be the 'mine' of tomorrow. There should not be any waste collection and the business is to be designed on permaculture principles. Things must be reused first and then recycled in all possible materials: cardboard, paper, glass, textiles. All organic materials, from kitchen waste to shredded paper are to be composted. The subsequent compost feeds the edible container garden and provides a medium for growing plants for other projects at the Sustainability Centre.

- **DESIGN FROM PATTERNS TO DETAILS:**

“Can't see the forest for the trees”

There needs to be an 'edge' between house and garden. And we must make both productive aesthetic and in terms of energy harvesting and food crops. The pattern of what sustainable living might be, with examples from other places, and then we refined our exploration into the detail appropriate for our particular site. We didn't make a 'shopping list' of individual items or projects and try to mesh them together in a hotchpotch of what might be regarded as 'green'.

- **INTEGRATE RATHER THAN SEGREGATE:**

“Many hands make light work”

Using hard edges to design our spaces is a cultural tendency to separate veggie gardens from flower gardens. The gardeners know that the more integrated the orchard is with the wildflower meadow, or the vegetables are with flowers frequented by beneficial insects, the less pests will prevail. The same is true for people. Cultural diversity yields a robust and fertile culture, whereas a rigid monoculture of politics and religion can bring sterility, even social and political repression.

- **USE SMALL AND SLOW SOLUTIONS:**

“Slow and steady wins the race”

Our society currently depends mainly on inputs of fossil fuels. But our biosphere is over-loaded by the output of fossil fuels. The more accessible and fixable our technology is, the more robust the system. This principle speaks of appropriate technology and of hand tools, that can easily be fixed.

If the fuel supply is interrupted, the shelves of super-market will go empty at an alarming rate. So it is better to build resilience into our systems by delocalizing our essential needs as much as possible, we must have technological alternatives so that we can fix.

- **USE AND VALUE DIVERSITY:**

“Don't put all your eggs in one basket”

Biodiversity creates healthy and efficient ecosystems. Diversity in terms of energy sources, crops and employment, make for greater sustainability. Valuing diversity amongst people makes for a more peaceful, equitable society. Conflict and wars are the biggest slayers of sustainable development.

- **USE EDGES AND VALUE THE MARGINAL:**

“Don’t think you are on the right track just because it’s a well-beaten path”

Examples of 'edge' in nature are: where river and sea meet land in the fertile interface of estuaries, full of invertebrates, bird and fish life; where canopy meets clearing in the woodland, inviting in sunshine and air and a profusion of flowers; where plains and water meet, flooding and capturing alluvial soils; where the banks of streams meet the water's edge and fertility is built with deposited mud and sand in flood time, giving life to a riot of plant life etc.

Edge in nature is defined as increasing diversity by the increase of inter-relationship between the elements: air, earth, water and fire (sun). This phenomenon increases the possibilities for life in all of its forms. In human society, edge is seen where we have cultural diversity. It is the place where creative thinkers and so-called 'alternative' people thrive. where new ideas are encouraged to develop and ageless wisdom is respected with its rightful freedom.

- **CREATIVELY USE AND RESPOND TO CHANGE:**

“Vision is not seeing things as they are but as they will be”

In nature, there is a process of succession. Bare soil is colonized by weeds that are in turn superseded by brambles. Then pioneers follow; like silver birch, alder and gorse which stabilize the soil. The latter two even fix nitrogen to create an environment that can host slow growing temperate climate species like oak, beech and yew. But nature is dynamic and succession can be interrupted by brow-sing animals, storms that fell trees and

create clearings or a changing climate that is less hospitable for certain climax giants like oak and beech.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This research work will mainly focus on **restoring the equilibrium** between **nature and man-made structures**. For this to happen it is necessary to have a thorough **understanding of the local eco system, climate, flora, fauna, material properties, soil type, soil composition, water flow, biotic communities, critical habitat at risk species etc.** of the selected city.

The flow of this research focuses on restoring the equilibrium between nature and man-made structures. For this to happen it is necessary to understand the parameters of Regenerative design and how it influences the energy, water, material used over the environment. Analysis is done based upon case studies to understand the form, orientation, design elements etc. Qualitative study relating producing questionnaires, research paper study and Internet study will be done to understand the context of regenerative architecture. Quantitative details such as Water calculations, Electricity calculation, Food waste, Rainwater calculation and environmental simulations will be carried out. So the selected site will be incorporated with all the mentioned study to conclude with the design.

This study will be a **qualitative approach** which focusses more on design elements to improve the quality of lifestyle of people and ecology within the site. For better understanding

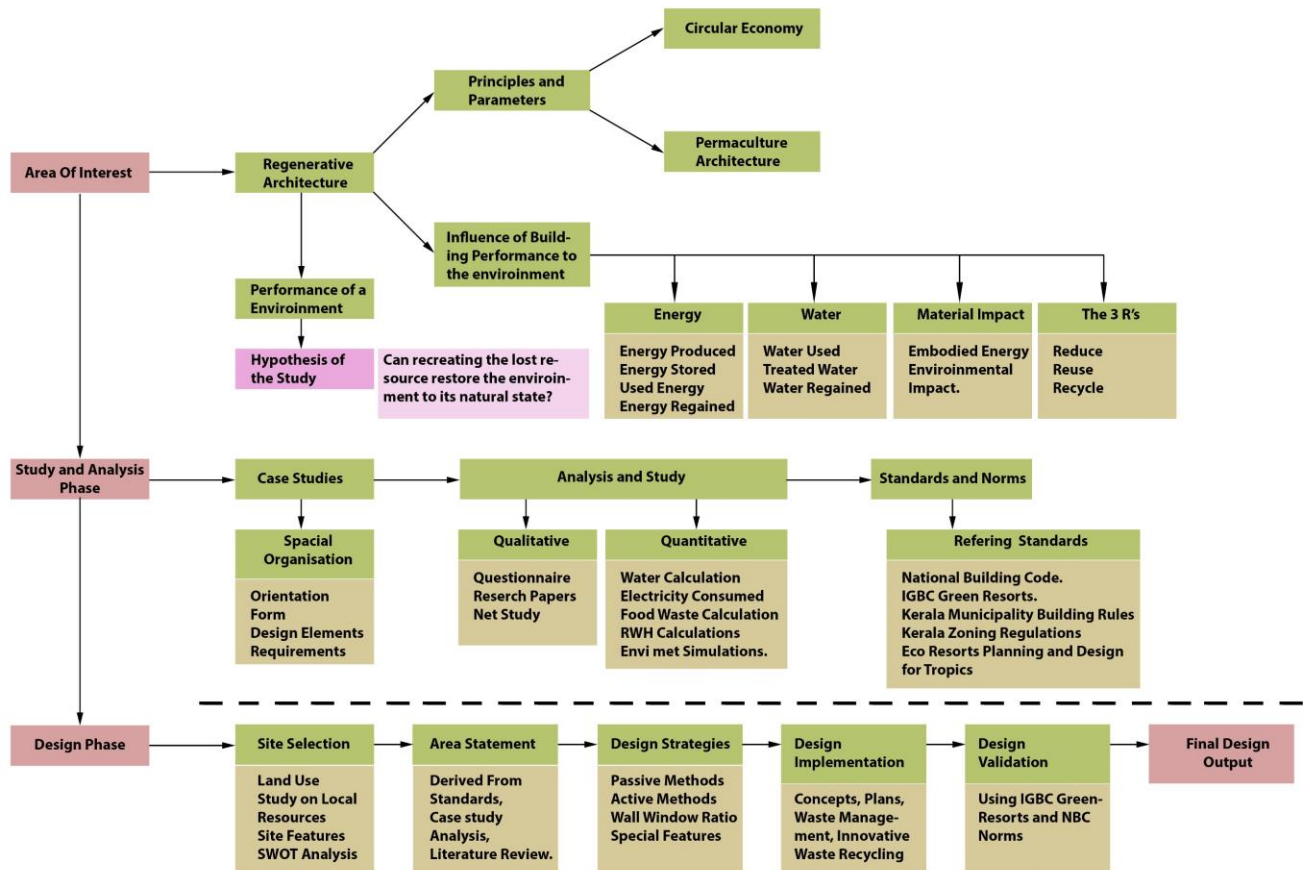


Fig 3.1 Figure of Methodology Adopted

3.2 IDENTIFICATION OF A CONTEXT

The Banasura Resorts is claimed to be the largest mud resort in Asia at Vellamunda in the backdrop of Banasura hills, 18 km away from Mananthavady in Wayanad district, Kerala. The whole construction of the structure is done with mud and revolves around the gathering of materials that were available inside the site.

Regenerative Scope Identified:

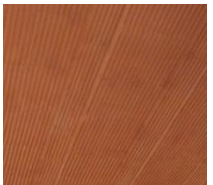
- No air-conditioners were needed as the mud walls act as an effective regulator of heat and cold. Moreover, there is a cooling stream flowing through the property.
- The Site features a bio-gas plant that recycles organic waste and fires the resort's kitchens.
- For extra Lighting CFL lamps are used as it minimizes energy consumption. These CFL lamps are used all over the site. Natural Lighting is used to its fullest.
- The resort is built entirely with mud and materials that are available around the site.
- Most of the woodwork is from recycled wood. To preserve its natural consistency cashew oil is used to treat the wood.
- Thousands of Guadua bamboo saplings planted around the resort create bio fencing while improving the already pristine air quality. Soil erosion is controlled by planting Vetiver grass in critical areas.

3.3 MATERIALS IDENTIFIED ON THE SITE

The whole construction of the structure revolves around the gathering of materials that were available inside the site. Local construction techniques were implemented with the help of the local tribes who are living in and around the resort area. Terracotta tiles and Kurudis were outsourced with a local dealer but most of the materials used are only from the site.

Mud Construction is adopted to reduce the impact on the environment staying true to the nature of the context. The architectural design of the resort follows a rammed earth construction technique. The structures of the resort are constructed using mud excavated from the site itself. The area of the entire structure is about 20,000 square foot which is made entirely out of mud, with bamboo roofing and coconut palm fronds.

Table 3.1: Materials Identified

Materials used for Construction		
Walls	Clay and Mud Plaster Provides higher resistance to thermal radiation exposed to solar radiation. And thereby reducing the interior air temperature.	
Flooring	Terracotta Tiles The tiles are eco-friendly as it is made entirely out of the mud and has a good resistive property.	
Ceiling	Thatch roof with Terracotta Kurudis insulation - In warm and cold weather, the thatch has air pockets that store air and thereby regulating the temperature inside the structure by keeping it warm in winters and cooler in summer. - Installing Kurudis below the thatch roof is also an added advantage to cut down excess heat that penetrates through and keeping the earth room much more cool during summer.	

Mud Construction has a R - value of 0.35-0.70 Km^2/W which varies according to the thickness of the wall and a U-value of 1.9 $\text{W}/\text{m}^2\text{K}$ and the thermal storage capacity is about 1830 $\text{kJ}/\text{m}^3\text{K}$.

When It comes to mud construction they have an advantage of being cost effective and local resource but at the same time they are time consuming and labour intensive. The overall cost of the building will depend upon the design and the type of finishes one expects from it. The technologies that are implemented are cost effective as such. Two types of mud construction technologies can be taken into consideration in this context, which are Compressed Earth Stabilized Block (CSEB) and Stabilized rammed earth. For this structure they have went with stabilized rammed earth technique.

A finished Compressed Earth Stabilized Block (CSEB) is less expensive than a conventional wire cut brick or fired brick. Walls made out of CSEB masonry is already cheaper than a fired brick wall which is further more cost efficient when the same wall is built using a stabilized rammed earth technique. Which concludes that rammed earth technique is cheaper than CSEB. The material for both CSEB and rammed earth wall remains the same but the difference comes when the bricks has to be moulded made and cured on ground and later built by masons which is labour intensive when compared to rammed earth construction. So overall cost of a finished rammed earth wall is cheaper than a CSEB block work by about 20%-30% and 30%-50% for the same when it is constructed using fired brick.

3.4 TEMPERATURE AND COMFORT BAND

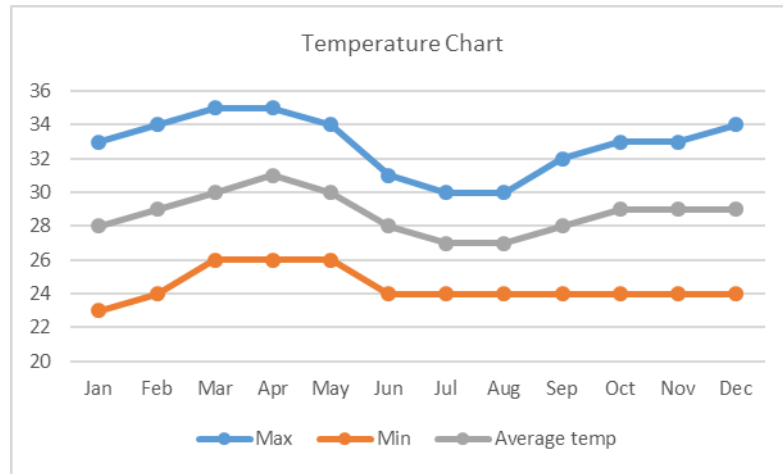


Fig 3.2 Temperature Graph

Summer - March, April, and May, are the months of summer. Temperature Ranges from 34°C -36 °C. and the Humidity ranges between 73%-79% on average.

Monsoon - The air temperature during the season of monsoon fluctuates between 24°C and 32°C. The annual precipitation ranges from 167mm on average.

Winter - The air temperature during winter fluctuates between 22°C and 30°C.

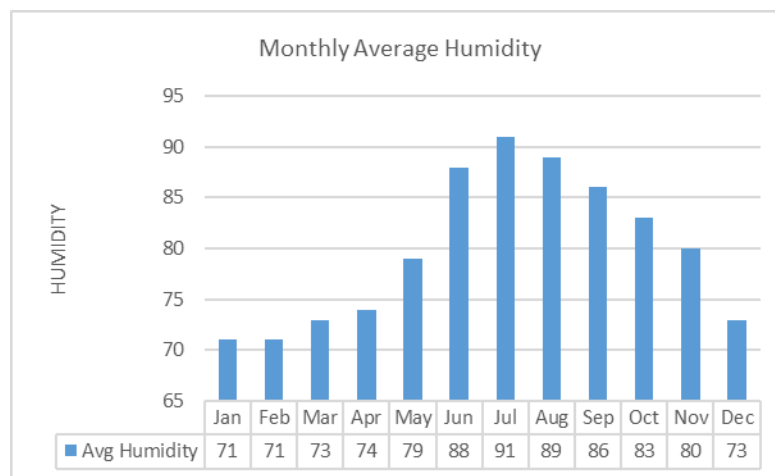


Fig 3.3 Humidity Graph

The Relative Humidity's comfort band ranges from 30% - 60% According to ASHRAE Standard 55 Thermal Comfort Assessment. This Graph signifies that Waynad has a higher humidity level and does not fall under the comfort band.

3.5 NICOL GRAPH

To identify the Comfort band for temperature “Nicol Graph” is used. “Nicol graph” uses the comfort temperature for free-running buildings (T_{comf}) calculated for each month. The comfort temperature is calculated from the mean outdoor temperature (T_{om}) which is derived from the monthly mean of the daily maximum ($T_{\text{o max}}$) and minimum ($T_{\text{o min}}$) temperatures from meteorological records. The comfort temperature is calculated using the equation.

$$T_{\text{comf}} = 0.54 T_{\text{om}} + 12.9$$

This equation is from the analysis by Humphreys and Nicol (2000) of data from comfort surveys. The Nicol graph allows us to compare the desired indoor temperature (T_o) with the mean and range of outdoor temperatures - suggesting possible passive cooling or heating strategies.

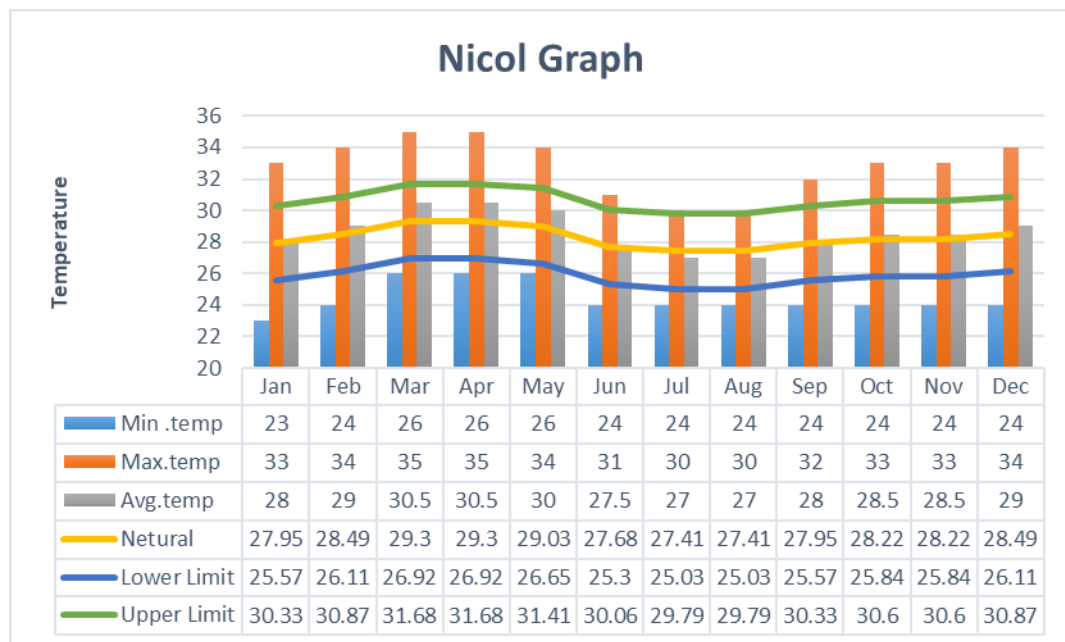


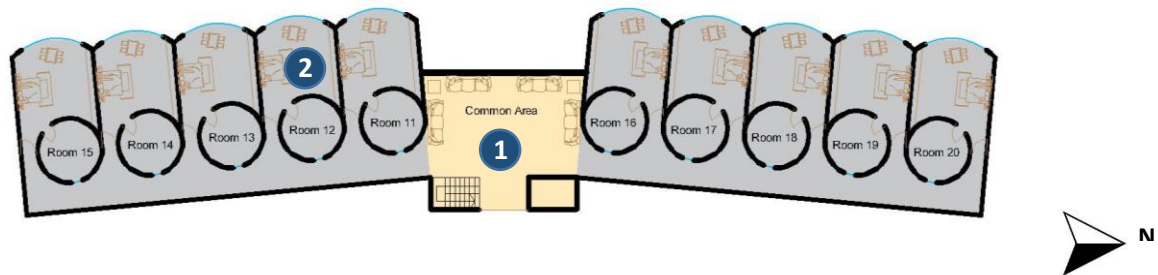
Fig 3.4 Nicol Graph for Waynad

Table 3.2: Nicol Comfort Band for Wayanad

Nicol Comfort Band For Wayanad												
Temp/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	25	26	26	26	26	25	25	25	25	25	25	26
Max	30	30	31	31	31	30	29	29	30	30	30	30

The achieved temperature is the interior comfort band for Waynad. So, any temperature that falls in-between the range is considered as a comfortable temperature inside the structure. So on average, we can say that 25°C - 31°C is the Nicol comfort band for Waynad.

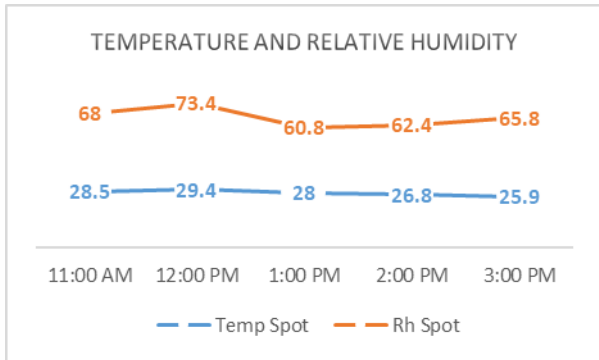
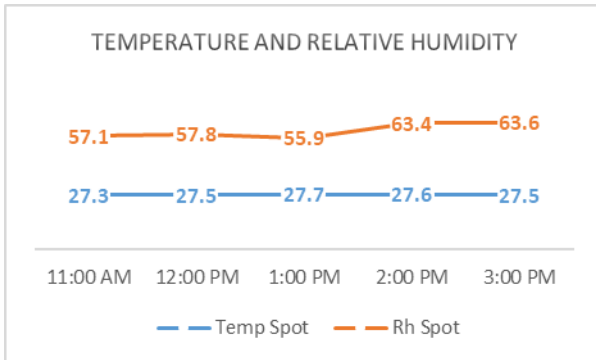
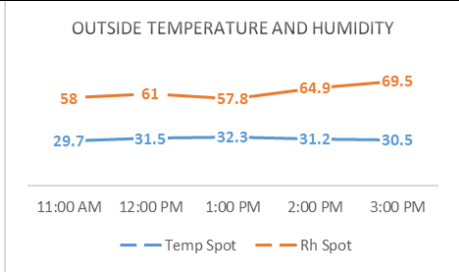
3.6 ROOM TEMPERATURE ANALYSIS FOR THE EARTH STRUCTURE



*Points 1 and 2 are the locations where the readings were taken for analysis.
Point 1 – Common area, Point 2 – Inside an Earth Room.

Fig 3.5 Plan of the Earth Structure

Table 3.3: Room Temperature Analysis

Room Temperature Analysis																																						
Point 1 – Common Area		Point 2 – Earth Room																																				
Here the Temperature tends to reduce gradually from 28°C to 25°C as the time passes by from 11 am – 3 pm and here we can see that the temperature tends to stay inside the comfort band suggested by Nicol Graph which is 25°C - 31°C		Here the Temperature tends to maintain at 27°C as the time passes by from 11 am – 3 pm and here we can see that the temperature tends to stay inside the comfort band suggested by Nicol Graph which is 25°C - 31°C.																																				
TEMPERATURE AND RELATIVE HUMIDITY <table><thead><tr><th>Time</th><th>Temp Spot (°C)</th><th>Rh Spot (%)</th></tr></thead><tbody><tr><td>11:00 AM</td><td>28.5</td><td>68</td></tr><tr><td>12:00 PM</td><td>29.4</td><td>73.4</td></tr><tr><td>1:00 PM</td><td>28</td><td>60.8</td></tr><tr><td>2:00 PM</td><td>26.8</td><td>62.4</td></tr><tr><td>3:00 PM</td><td>25.9</td><td>65.8</td></tr></tbody></table>		Time	Temp Spot (°C)	Rh Spot (%)	11:00 AM	28.5	68	12:00 PM	29.4	73.4	1:00 PM	28	60.8	2:00 PM	26.8	62.4	3:00 PM	25.9	65.8	TEMPERATURE AND RELATIVE HUMIDITY <table><thead><tr><th>Time</th><th>Temp Spot (°C)</th><th>Rh Spot (%)</th></tr></thead><tbody><tr><td>11:00 AM</td><td>27.3</td><td>57.1</td></tr><tr><td>12:00 PM</td><td>27.5</td><td>57.8</td></tr><tr><td>1:00 PM</td><td>27.7</td><td>55.9</td></tr><tr><td>2:00 PM</td><td>27.6</td><td>63.4</td></tr><tr><td>3:00 PM</td><td>27.5</td><td>63.6</td></tr></tbody></table>	Time	Temp Spot (°C)	Rh Spot (%)	11:00 AM	27.3	57.1	12:00 PM	27.5	57.8	1:00 PM	27.7	55.9	2:00 PM	27.6	63.4	3:00 PM	27.5	63.6
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Inference: The analysis was done on 22nd march 2021 which comes under the summer month which has the highest temperature range of 26°C - 35°C outside. When Comparing the interior air temperature against the exterior temperature we can see a reduction of 2°C - 3°C. The interior temperature tends to maintain at 28°C and the outside temperature is 2°C higher at the same time.																																						

3.7 SURFACE TEMPERATURE ANALYSIS

Table 3.4: Interior Surface Temperature Analysis

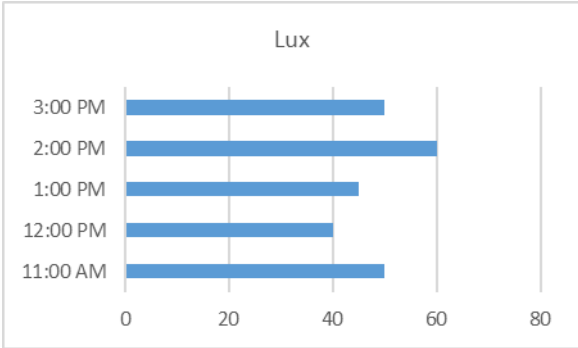
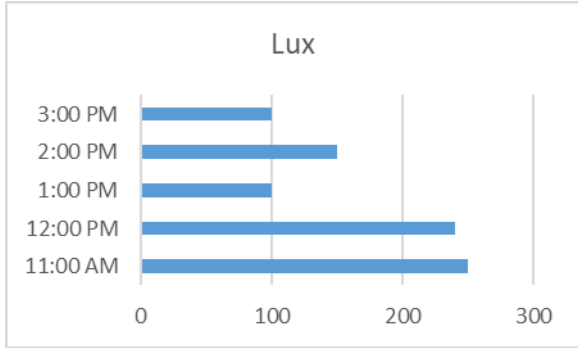
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Surface Temperature <table><thead><tr><th>Time</th><th>Roof</th><th>Wall</th><th>Floor</th></tr></thead><tbody><tr><td>11:00 AM</td><td>25.5</td><td>22.5</td><td>22.5</td></tr><tr><td>12:00 PM</td><td>26.5</td><td>23.5</td><td>23.0</td></tr><tr><td>1:00 PM</td><td>26.5</td><td>23.5</td><td>23.0</td></tr><tr><td>2:00 PM</td><td>27.5</td><td>23.5</td><td>23.0</td></tr><tr><td>3:00 PM</td><td>27.5</td><td>23.5</td><td>23.0</td></tr></tbody></table>	Time	Roof	Wall	Floor	11:00 AM	25.5	22.5	22.5	12:00 PM	26.5	23.5	23.0	1:00 PM	26.5	23.5	23.0	2:00 PM	27.5	23.5	23.0	3:00 PM	27.5	23.5	23.0	Surface Temperature <table><thead><tr><th>Time</th><th>Roof</th><th>Wall</th><th>Floor</th></tr></thead><tbody><tr><td>11:00 AM</td><td>22.5</td><td>21.5</td><td>22.5</td></tr><tr><td>12:00 PM</td><td>22.5</td><td>22.5</td><td>22.5</td></tr><tr><td>1:00 PM</td><td>22.5</td><td>23.0</td><td>22.5</td></tr><tr><td>2:00 PM</td><td>22.5</td><td>22.5</td><td>22.0</td></tr><tr><td>3:00 PM</td><td>22.5</td><td>22.5</td><td>21.5</td></tr></tbody></table>	Time	Roof	Wall	Floor	11:00 AM	22.5	21.5	22.5	12:00 PM	22.5	22.5	22.5	1:00 PM	22.5	23.0	22.5	2:00 PM	22.5	22.5	22.0	3:00 PM	22.5	22.5	21.5
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Inference: In this comparison, we can see a difference in temperature between two specific spaces inside the same structure within a couple of meters apart.																																																	

The reason for this is the variation of construction techniques between spaces.

The Common area has a roof treatment with only bamboo purlins and rafters with a thatch roof with insulation whereas for the rooms the same layer is followed but a layer of terracotta kurudis is added. This creates an air gap in-between further reducing the interior temperature inside the accommodation room. This kind of treatment is only done for the rooms.

3.8 LIGHTING ANALYSIS

Table 3.5: Lux Levels

Lighting Analysis																									
Point 1 – Common Area	Point 2 – Earth Room																								
 <table border="1"> <caption>Lux Levels - Point 1 – Common Area</caption> <thead> <tr> <th>Time</th> <th>Lux</th> </tr> </thead> <tbody> <tr> <td>3:00 PM</td> <td>50</td> </tr> <tr> <td>2:00 PM</td> <td>60</td> </tr> <tr> <td>1:00 PM</td> <td>45</td> </tr> <tr> <td>12:00 PM</td> <td>40</td> </tr> <tr> <td>11:00 AM</td> <td>50</td> </tr> </tbody> </table>	Time	Lux	3:00 PM	50	2:00 PM	60	1:00 PM	45	12:00 PM	40	11:00 AM	50	 <table border="1"> <caption>Lux Levels - Point 2 – Earth Room</caption> <thead> <tr> <th>Time</th> <th>Lux</th> </tr> </thead> <tbody> <tr> <td>3:00 PM</td> <td>100</td> </tr> <tr> <td>2:00 PM</td> <td>150</td> </tr> <tr> <td>1:00 PM</td> <td>100</td> </tr> <tr> <td>12:00 PM</td> <td>240</td> </tr> <tr> <td>11:00 AM</td> <td>250</td> </tr> </tbody> </table>	Time	Lux	3:00 PM	100	2:00 PM	150	1:00 PM	100	12:00 PM	240	11:00 AM	250
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2:00 PM	60																								
1:00 PM	45																								
12:00 PM	40																								
11:00 AM	50																								
Time	Lux																								
3:00 PM	100																								
2:00 PM	150																								
1:00 PM	100																								
12:00 PM	240																								
11:00 AM	250																								
The natural Light achieved in the common area is about 40 Lux on average. The reason for this is that mud tends to absorb the light in the atmosphere.	The natural Light achieved in the hearth room comes to around 100 Lux. The minimum requirement of Lux as per NBC standards is 100 lux which gets satisfied here.																								

Inference:

The Common area tends to receive a lesser lux level as compared to the earth room which receives 100 lux on average throughout the time. Since it is a common public area people won't use it more often so artificial lighting can be provided. And since it is double-height space ventilation and lighting are adequate without the need for artificial lighting.

3.9 CONCLUSION

We can see a significant reduction in the temperature and cost of construction plays a major impact on mud structures. In this research, we were also able to relate and compare how much temperature reduction can be achieved on a hot summer day. When comparing the interior air temperature with the Nicol graph we can conclude by saying that it is comfortable inside the structure as the temperature falls inside the comfort band.

Moreover, when it comes to regenerative aspects, mud is a natural material that does not alter the property of the land from which it is excavated. So more than exploitation, it can be told like a change in the composition of mud without any toxic chemicals in the mud. This is a way of conserving the natural state of the land. Restoring habitat will happen automatically as there won't be any kind of toxic substance around the structure so by this way regeneration can be initiated.

CHAPTER 4 STUDY OVERVIEW

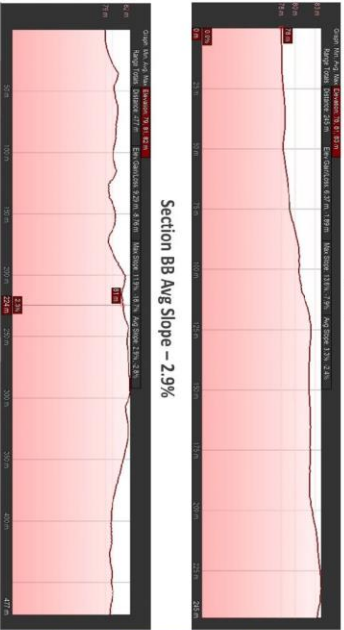
Site Selection And Site Analysis :

The Site is Located in Nemmara Nelliayampathi Road on the Way to Nelliayampathi Forest.



Site Pictures :

- The Selected Site is a live Proposal from Malabar Hotel and Resorts, Kerala
- It is Located in Nemmara which is 50 kms from Palakkad and Pollachi. With this Pothundi Dam is located about 2kms from the site which is selected.
- The Location experiences a Warm and Humid Climate.
- The Developer focusses on making a Eco Resort that blends with the fields with a capacity of 30 Homestays that comprises of Single Units and Double Units.
- The Total Area of the site Comes around 19 Acres with some vegetation.
- Only 10 Acres of the site is Going to be used for this development.
- Among this Plantation is going to be done in the North (4 Acres) and Southern Region (4 Acres) of the site.
- There is a water body available within the site due to undulations caused by natural factors.
- No Littering or Waste Disposal was found in it as well. So the site has a scope of regeneration without any kind of external means.



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Fig 4.1 Site Location and Details

Site Selection :

The Site is Free from any kinds of Vegetation on the proposed piece of land. A Boundary is Demarcated with a group of Coconut and Palm Trees around the site boundary. A natural Water body is formed during monsoon seasons temporarily inside the site.

TREES FOUND IN PALAKKAD DISTRICT

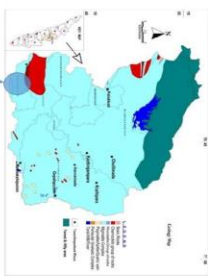
NAME	TYPE	USE
COCONUT	TREE	WOOD
PEEPAL	TREE	WOOD
NEEM	TREE	WOOD AND HERBS
TEAK	TREE	WOOD
KONGINI	SHRUB	ORNAMENTAL
THULASI	SHRUB	MEDICINAL

TREES INSIDE THE SITE



Local Rock Available:

MATERIAL RESOURCE AROUND THE SITE

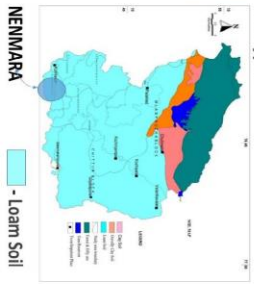


Rocks are used for various purposes starting from construction of roads, bridges, buildings to pot in kitchen, as a gem stone or just for decorating your garden. However, some rocks have rare properties. Migmatite uses in construction industry include As dimension stone, Cement manufacture, For road aggregate, Making natural cement.

Exterior – For Building Stone, As Facing Stone, Kerb aggregate, Making natural cement.



Soil Type :



Loam is the ideal soil type: typically it's a combination of sand, silt and clay. It is dark in color and soft, dry and crumbly to the touch. Loam is great for supporting foundations because of its evenly balanced properties, especially how it maintains water at a balanced rate. Loam is a good soil for supporting a foundation, as long as no miscellaneous soils find their way onto the surface.



Three layers of subsurface loam; surface layer is dark brown fine sandy loam, subsurface layer is red clay loam and sandy clay loam.

Hydraulic Lime:



- Company Name – "Pandiarathu Limestone Mine" For M/S MALABAR CEMENTS LIMITED.
- Hydraulic Lime Plant Located @ 50 Kms From Site.



Non Hydraulic Shell Lime:

- Company Name – Aishwarya Lime Shell Agencies
- Non Hydraulic Lime Plant Located @ 100 Kms From Site.
- In Kerala, the main source of lime is from shells.



- Non Hydraulic Lime Powder Costing, Rs 4.38 per kg
- Rs 4000 per Metric Ton
- A lease was executed on 04.08.1980. The lease is renewed on 26.08.2003 for period of 20 years, upto 25.08.2023.
- Total geological reserve: 1,09,28,967.174 Tonnes
- Extractable reserve: 7,689,834.306 Tonnes
- Per cent (%) of extraction: 85%



- Hydraulic Lime Powder Costing, Rs 14 per kg
- Rs 9800 per Metric Ton
- There were many local techniques of using lime within Kerala itself.
- Many organic items were added to increase the strength of the lime mortar.
- Lime made from shells was used as mortar for the superstructure shells were burnt in kilns.

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Fig 4.2 Local Materials Available

Climate Analysis: LOCATION : NENMARA, KERALA
 Latitude / Longitude: 10.554586 ° N, 76.614237 ° E
 Elevation: 82 m
 Time Zone (GMT+5:30)

DRY BULB VS RELATIVE HUMIDITY
 In months February to May the humidity also ranges high in 8 AM – 8 PM.

It is mandatory to remove or reduce the humidity levels.

HUMIDITY RANGE 8 AM – 8 PM
 The Humidity ranges are high and therefore making the area uncomfortable.

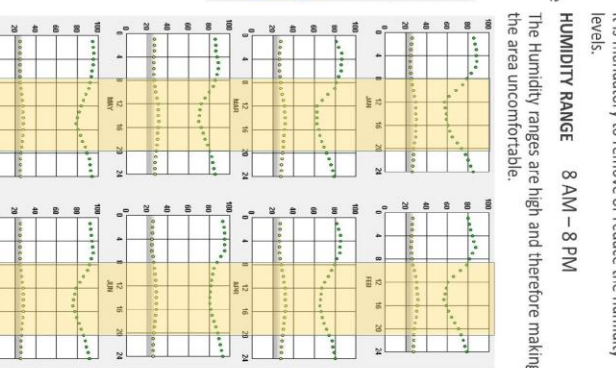
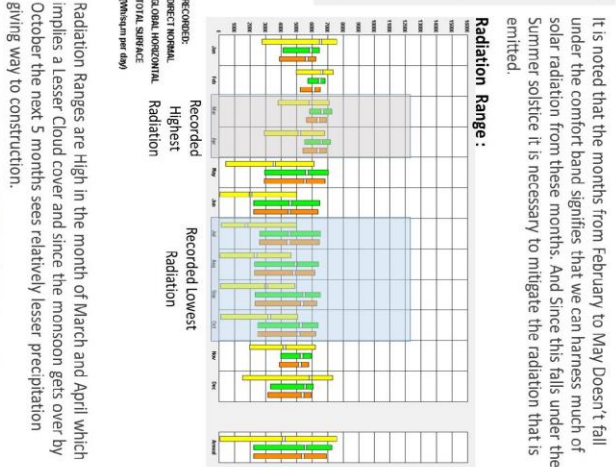
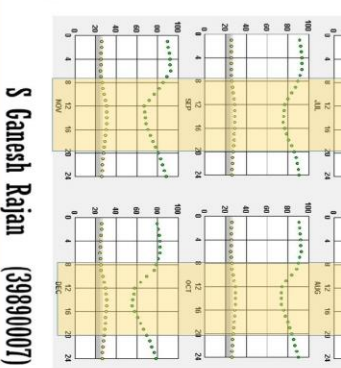
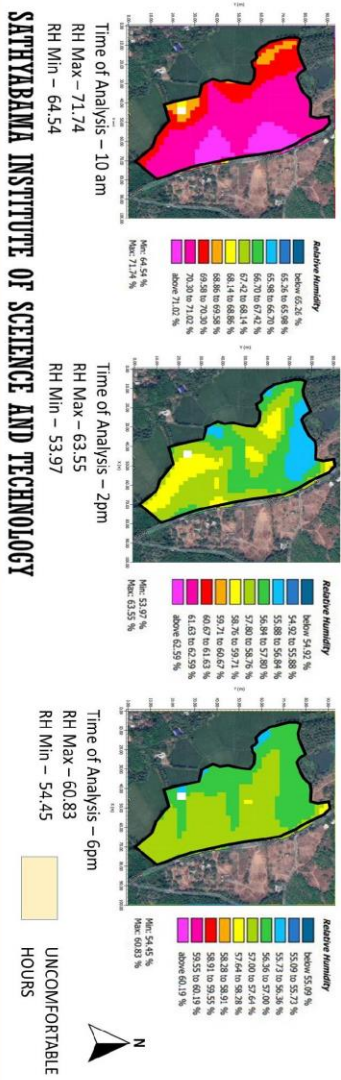


Fig 4.3 Climatic Influence in Nenmara

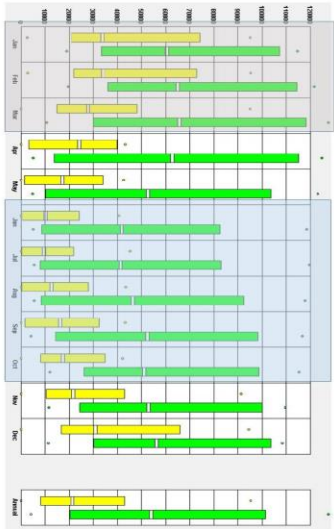


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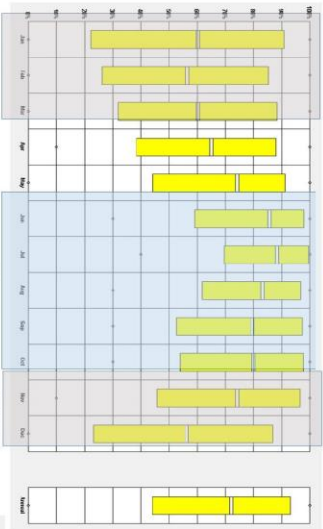
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ILLUMINATION RANGE



SKYCOVER RANGE

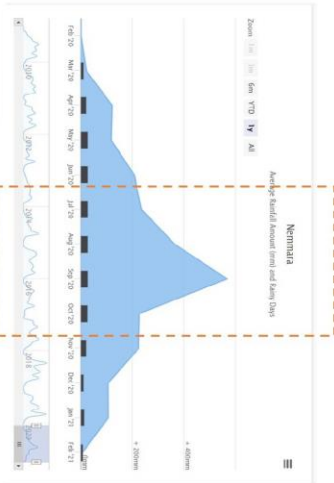


SKY COVER RANGE INFERENCE:

Since the Months June – October tends to be the monsoon Period The illumination tends to be at a diffused state giving a average of 10,000 LUX.

In the Months of Jan to Mar the illumination has a lesser Diffused property and so Glare Component needs to be taken care of by providing soft scape

ANNUAL RAINFALL MONTH:



Monsoon Season from Jul to Oct

WIND ANALYSIS INFERENCE :

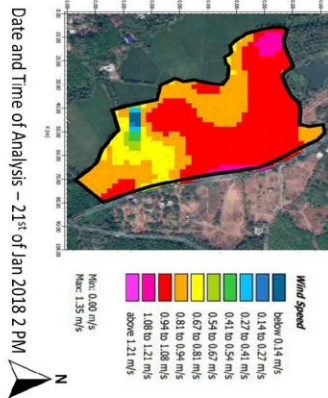
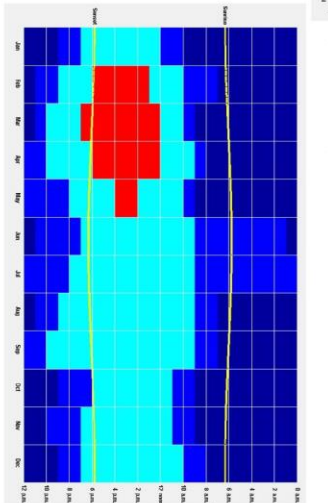
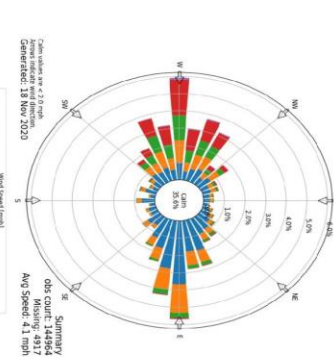
The Date Recorded – 18 Nov 2020

The Predominant Wind Direction is generally through West to East and East to West.

Average Speed Ranges Around 4 mph

Light breeze is expected all around the site so provisions for wind tunnel effect for cross ventilation purpose needs to be incorporated.

WIND ROSE OF NENEMARA :



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Fig 4.4 Climatic Influence in Nenemara

Date of Analysis – 22st of March 2021

TIME	AIR TEMPERATURE	RELATIVE HUMIDITY
10 AM	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Morning 10 Am 27°C to 29°C HRC: 10.07°C HRC: 29.05°C	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Morning 10 Am 27°C to 29°C HRC: 10.07°C HRC: 29.05°C
12 PM	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Afternoon 12 Pm 29°C to 32°C HRC: 12.09°C HRC: 32.07°C	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Afternoon 12 Pm 29°C to 32°C HRC: 12.09°C HRC: 32.07°C
2 PM	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Afternoon 2 Pm 31°C to 34°C HRC: 14.07°C HRC: 34.07°C	Potential Air Temperature below 21.1°C 21.1 to 22.44°C 22.44 to 23.67°C 23.67 to 24.69°C 24.69 to 25.61°C 25.61 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C above 28.03°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Afternoon 2 Pm 31°C to 34°C HRC: 14.07°C HRC: 34.07°C
4 PM	Potential Air Temperature below 22.2°C 22.2 to 23.78°C 23.78 to 25.21°C 25.21 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C 28.03 to 28.99°C 28.99 to 29.82°C 29.82 to 31.46°C 31.46 to 32.57°C above 32.57°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Evening 4 Pm 32°C to 36°C HRC: 16.71°C HRC: 36.06°C	Potential Air Temperature below 22.2°C 22.2 to 23.78°C 23.78 to 25.21°C 25.21 to 26.37°C 26.37 to 26.93°C 26.93 to 27.35°C 27.35 to 28.03°C 28.03 to 28.99°C 28.99 to 29.82°C 29.82 to 31.46°C 31.46 to 32.57°C above 32.57°C Relative Humidity below 65.1% 65.1 to 70.3% 70.3 to 72.35% 72.35 to 74.4% 74.4 to 76.44% 76.44 to 78.48% 78.48 to 80.53% 80.53 to 82.57% above 82.57% Evening 4 Pm 32°C to 36°C HRC: 16.71°C HRC: 36.06°C

Temperature:

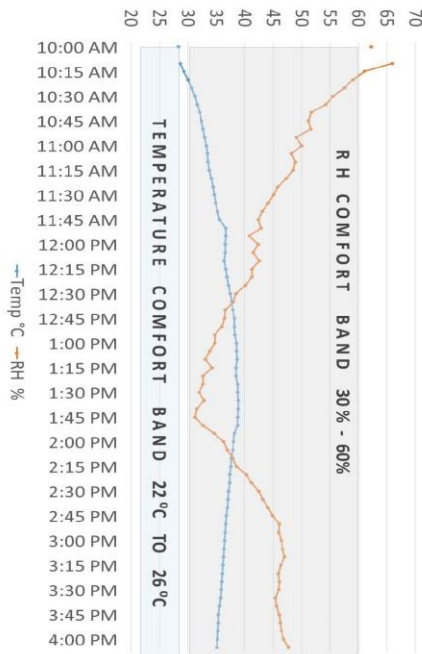
According to ASHRAE Standard 55 Thermal Comfort Assessment the Comfort Band ranges from 20 °C to 27 °C, for a normal human to be comfortable. The place Nennmaria does not come under the comfort band at any point of the day as the temperature at 10 am morning starts by 28 °C and it steadily increases and its peak reaches at 1:45 Pm with temperature 38 °C. Around 4 pm in the evening the temperature gradually reduces to 35 °C and still reducing further.

Relative Humidity:

The Relative Humidity's comfort band ranges from 30% - 60% According to ASHRAE Standard 55 Thermal Comfort Assessment in this chart we can clearly see that the Relative humidity falls under the comfort band in most time of the day

HOB0 DATA LOGGER : Date of Analysis – 22st of March 2021

Temperature and Relative Humidity



HOBO DATA LOGGER VS ENVIMET COMPARISON:

Temperature Chart



Temperature:

The Onsite temperature surpasses the Max temperature suggested by Software analysis. The variation is less around in the mornings and around 12 noon and 2 pm there is a remarkable difference of about 4 °C by 12 noon and it gets reduced by 3 °C by around 2 pm and gradually coming into the suggested max temperature around 4pm in the evening.

Both the Envirotest Result and Hobo data logger measurement does not come under the comfort band suggested by ASHRAE 55 Standard Thermal Comfort Assessment.

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MAHONEY'S TABLE COMFORT BAND :

S.NO	MONTH	MAX °C	ET	MIN °C
1	January	27°		17°
2	February	28°		18°
3	March	29°		19°
4	April	31°		22°
5	May	29°		20°
6	June	28°		19°
7	July	27°		18°
8	August	27°		18°
9	September	30°		18°
10	October	27°		18°
11	November	27°		18°
12	December	27°		18°

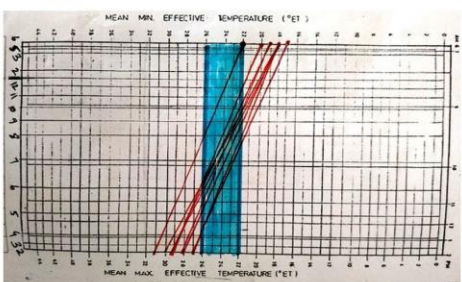
The Comfort Band arrived from Mahoney's table states a Temperature of,

Min – 22 °C

Max - 26 °C

And the Months April and September experiences the Highest effective temperature of about 31°C.

COMFORT BAND :



Mahoney's table suggests that in march from the time 09:00 Am-10:00 Am are comfortable in the mornings and the time 06:00 Pm - 10:00 Pm are considered as comfortable hours in the evening.

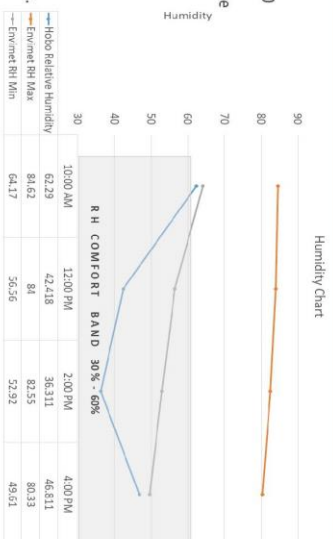
The site experiences a hot uncomfortable climate through the entire period of time.

But the readings were took from 10:00 Am – 04:00 Pm which comes under the Uncomfortable time range.

Relative Humidity :

This on the other hand has similar difference but here the relative humidity tends to go further below the suggested RH minimum value but staying into the comfort band.

Both the results fall well inside the comfort band of Relative humidity suggested by ASHRAE 55 Standard Thermal Comfort Assessment. The Comfort Range of Relative Humidity Ranges from 20% to 70%



NICOL GRAPH :

Since the ASHRAE comfort band 22 °C -26 °C is not practical to achieve in India the formula driven Nicol graph helps us to get the adequate interior comfort temperature.

The Nicole's comfort band varies from month to month and the comfort band ranges from 23 °C. -30 °C. and the average comfortable temperature without the need for Air conditioning facility is about 26 °C

Temperature :

The Site at Nemmara reaches a max temperature of 37 °C in the months of march and april which is way beyond the comfort band.

The months June to august experiences the most comfortable months over the entire year as the temperature range fluctuate between 20 °C -30 °C

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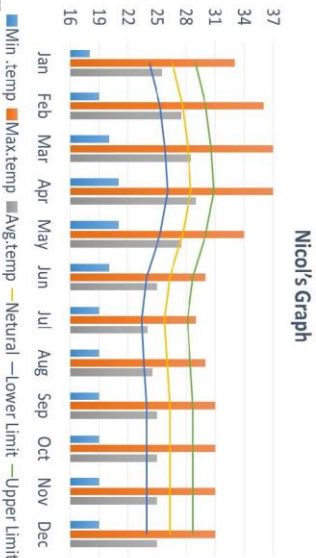
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Months	Min temp	Maxtemp	Avg.temp	Neutral	Lower Limit	Upper Limit
Jan	18	33	25.5	26.6	24.22	28.98
Feb	19	36	27.5	27.68	25.3	30.06
Mar	20	37	28.5	28.22	25.84	30.6
Apr	21	37	29	28.49	26.11	30.87
May	21	34	27.5	27.68	25.3	30.06
Jun	20	30	25	26.33	23.95	28.71
Jul	19	29	24	25.79	23.41	28.17
Aug	19	30	24.5	26.06	23.68	28.44
Sep	19	31	25	26.33	23.95	28.71
Oct	19	31	25	26.33	23.95	28.71
Nov	19	31	25	26.33	23.95	28.71
Dec	19	31	25	26.33	23.95	28.71

Nicole's Comfort band



The Site at Nemmara reaches a max temperature of 37 °C in the months of march and april which is way beyond the comfort band.

The months June to august experiences the most comfortable months over the entire year as the temperature range fluctuate between 20 °C -30 °C

Fig 4.6 Nicol Comfort Band for Nemmara

SITE PLAN



Fig 4.7 Site Plan

TEMPERATURE AND RELATIVE HUMIDITY COMPARISON AFTER ADDING THE WATER RESERVOIR :

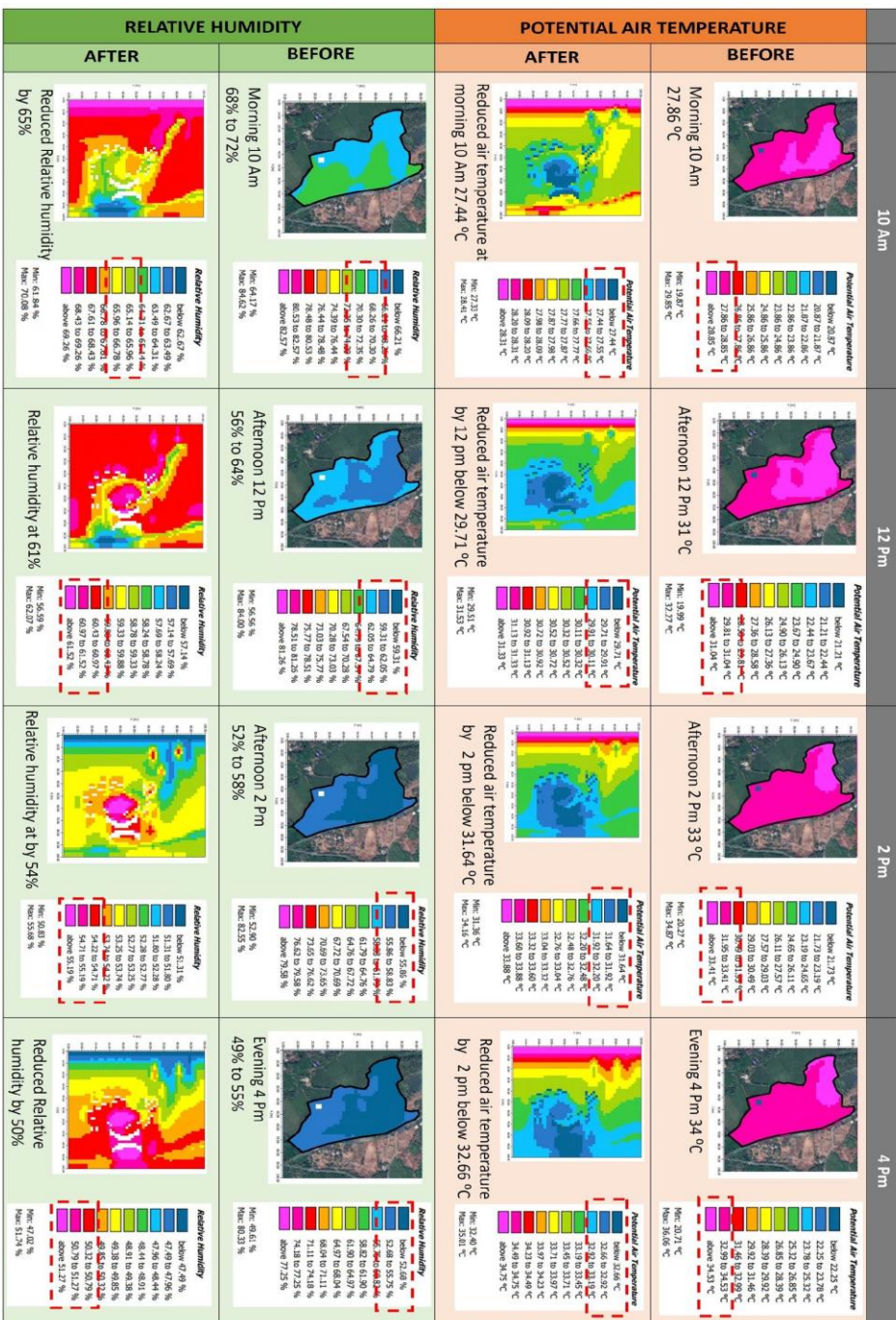


Fig 4.8 Influence of Water Body

From this table, we can infer that after adding the reservoir we can see that there is a reduction in temperature of about 2 °C than the actual existing temperature. Where as the Relative humidity tends to maintain or fluctuate between 50% - 65%.

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Shape	Orientation	Solar Analysis	Wind Analysis
Cube Oriented at 30°			
Base case Started with a Cube form and tilted it 30° (From NZEB Website) with respect to the direction of wind.			
Shorter shadow is achieved at the west direction.		Surface area exposed to solar radiation is higher in this option as compared to the others.	Form is placed at 30° orientation of wind direction to better utilise the ventilation here the wind speed tends to nullify at the edges and get deviated from the building.
Max speed – 5 m/s			
Semi Cube Oriented at 30°			
My next iteration is having a curved profile on the West face where wind plays a role in ventilation.			
Shadow achieved here is very much better in terms of area covered as compared to previous options.		We can see a reduction in solar radiation on the curved surface exposed to the sun on the west.	Form is placed at 30° orientation of wind direction to better utilise the ventilation here the wind experiences a aerodynamic edge so the direction doesn't get deviated.
Max speed – 5 m/s			
Semi Cube Oriented at 45°			
Longer shadow is cast towards the west direction as compared to the previous option.		Surface area exposed to solar radiation is better in this option as compared to the others.	Form is placed at 45° orientation of wind direction to better utilise the ventilation here the wind experiences a aerodynamic edge so the direction doesn't get deviated.
Max speed – 4.8 m/s			

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Cylinder

My next iteration is having a curved profile on all the faces.

Shadow achieved here is longer and surface covered on shadow is higher than the other options.

We can see a reduction in solar radiation on all the sides due to less surface area exposed to a solar radiation.

The form itself is aerodynamic in nature so wind tends to pass through the sides without any disturbance.

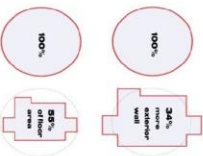
Circle Vs Other Forms:

Less Material Requirement:

Of any shape a circle has the shortest boundary relative to it's area.

A round house has less wall length, thus fewer materials are required to built it.

15 - 20% less material is needed to create the same size building compared to a rectangular design...



More Energy Efficient:

As a Round House has a lower surface area relative to floor space when compared to a rectangular building, this means that as there is a reduced area exposed to the weather outside it will take less energy to heat / cool the interior.

Round Houses are also more aerodynamic and so admit fewer draughts.

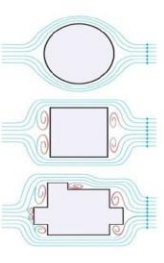
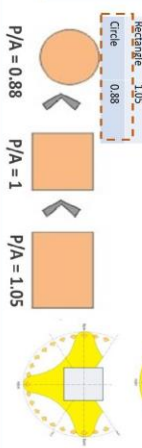
Seismic Stability:

A Round House has dozens of interconnected points which give it a unique combination of flexibility and strength - qualities that make them significantly stronger than rectangular buildings during earthquakes..

Perimeter / Area Ratio :

The P/A (Perimeter/Area) ratios indicate radiative gains or losses and efficient ventilation. Low P/A ratios are suitable for hot dry climates.

Lesser the P/A the more efficient the structure performs.



Maximum Day Lighting and solar Energy:

It promotes optimal exposure to daylight and solar energy throughout the day, as at all times the sun's rays are perpendicular to the Round House exterior wall.

Fig 4.9 Pros of a Cylindrical Wall

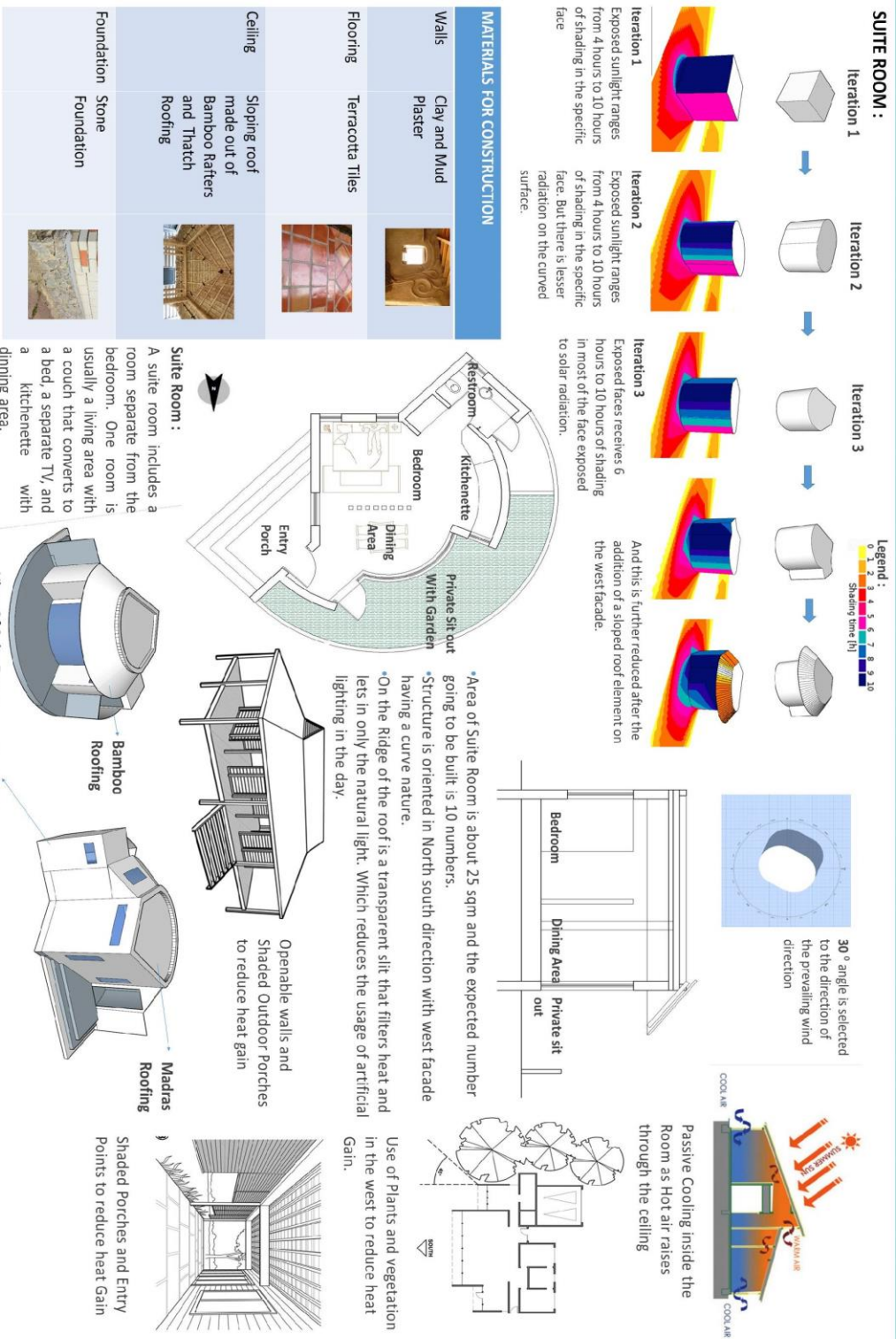
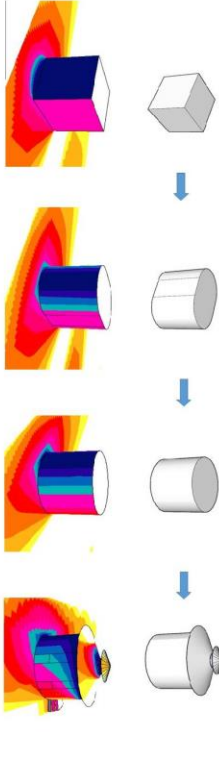


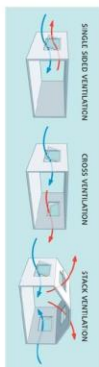
Fig 4.10 Typology – 1 – Suite Room

Legend:

0 1 2 3 4 5 6 7 8 9 10



Reduced in solar radiation on all the sides due to less surface area exposed to a solar radiation.



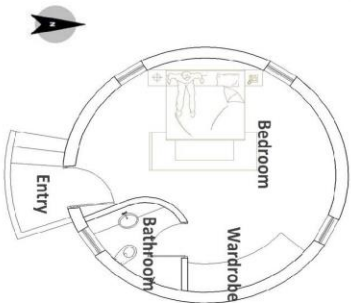
The Concept of Stacked ventilation promotes the outlet of Hot air through the Openable ventilators in the roof.

Iteration 2
Exposed sunlight ranges from 4 hours to 10 hours of shading in the specific face. But there is lesser radiation on the curved surface.

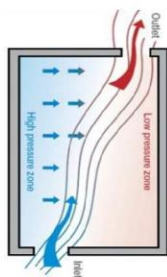
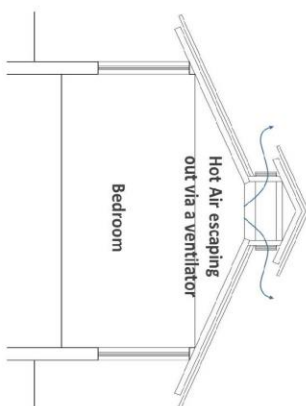
Iteration 3
Since the surface area of solar radiation is increased there more area is under the

Addition of a Projection
on the roofing material
we can see a increased
time of shadows on the
structure

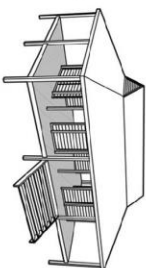
Walls	Clay and Mud Plaster	
Flooring	Terracotta Tiles	
Ceiling	Sloping roof made out of Bamboo Rattens and Thatch Roofing	
Foundation	Stone Foundation	



- Area of Cottage is about 19 sqm and the expected number going to be built is 10 numbers.
- it has a curved profile to reduce the solar radiation falling on it.
- Entire structure is constructed using mud and the foundation is to be laid by stones.



Temperature Differences
between warm and cool air inside the room can cause the air in the room to raise and exit at the ceiling or ridge and enter via the lower openings in the wall.



Long Eaves reduces the solar radiation on walls by casting shadows to promote self shading

Cottage:

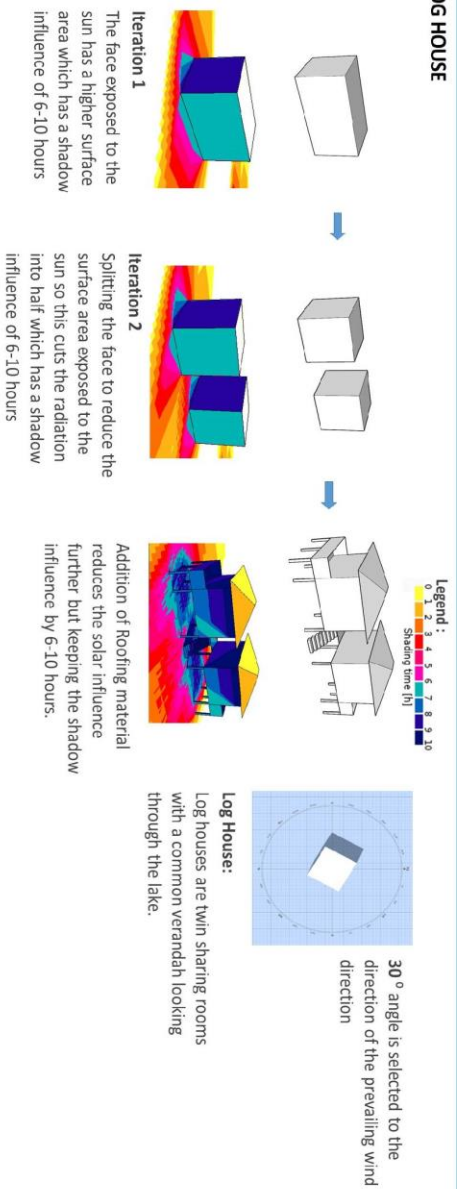
A cottage includes a single room with toilets attached to it. And it is not so premium like the suite rooms.

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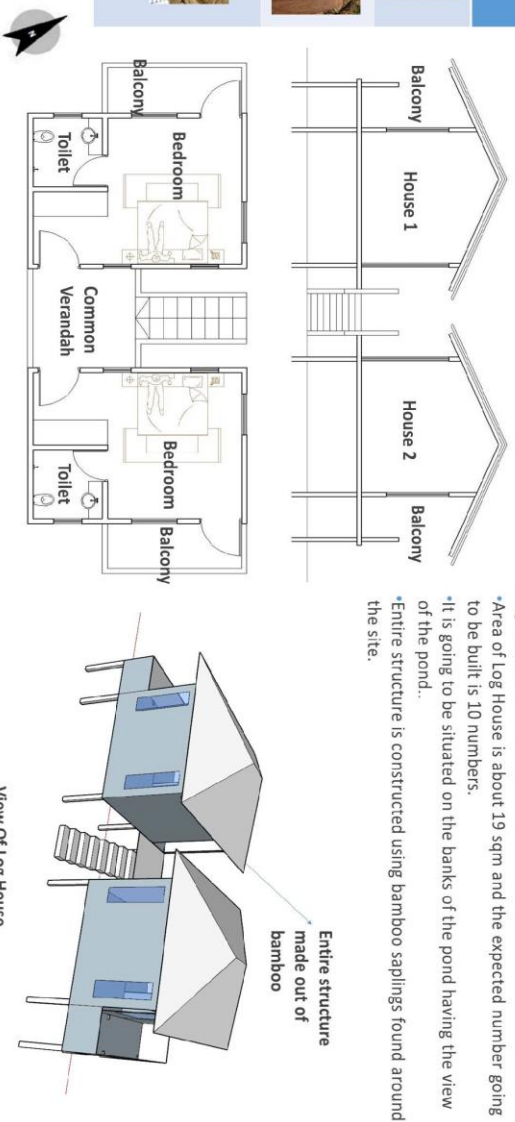
Fig 4.11 Typology – 2 – Cottage

LOG HOUSE



MATERIALS FOR CONSTRUCTION

Walls	Bamboo Walls
Flooring	Local Wood Planks
Ceiling	Sloping roof made out of Bamboo Rafter's and Thatch Roofing



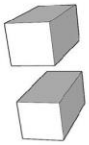
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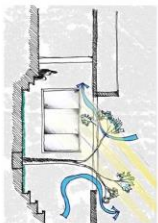
Fig 4.12 Typology – 3 - Log House



Legend:
Shading time [h]



30° angle is selected to the direction of the prevailing wind direction



Provides ample natural day light without the need for any artificial lighting during the day times. Also has a sense of connect with the nature within the structure.

The face exposed to the sun has a higher surface area which has a shadow influence of 6-10 hours	Splitting the face to reduce the surface area exposed to the sun so this cuts the radiation into half which has a shadow influence of 6-10 hours	Do
--	--	-----------

Iteration 2
Splitting the face to reduce the surface area exposed to the sun so this cuts the radiation into half which has a shadow influence of 6-10 hours **Do**

Addition of Roofing material reduces the solar influence further but keeping the shadow influence by 6-10 hours.

influence by 6-10 hours.

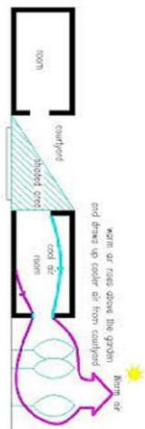
- Unlike other structures the dormitory is articulated in such a way that it is in a rigid shape like a square.

- In the Centre is a green courtyard that has plants and trees and all forms of vegetation.

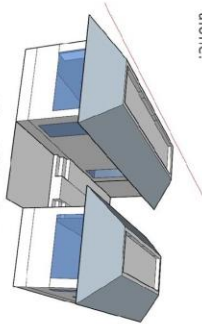
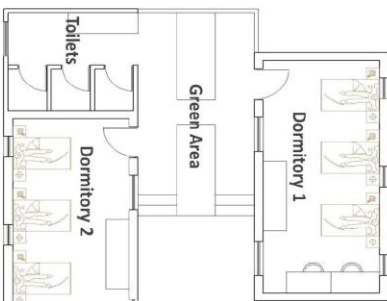
- The roof is traditional flat roof with roof insulations on it. This dormitory is aimed for nature lovers who travel alone.

Warm air raises above the vegetation and draws the cooler air from the court yard.

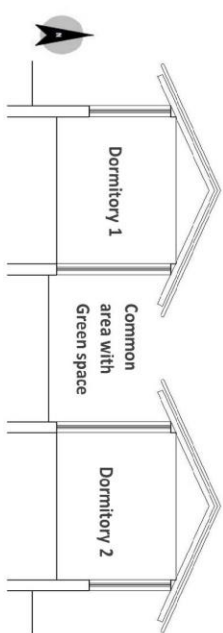
Warm air raises from the court yard drawing the cooler air from the atmosphere.



MATERIALS FOR CONSTRUCTION		
Walls	Clay and Mud Plaster	
Flooring	Terracotta Tiles	
Ceiling	Sloping roof made out of Bamboo Rafter and Thatch Roofing	
Foundation	Stone Foundation	



View Of Dormitory



48

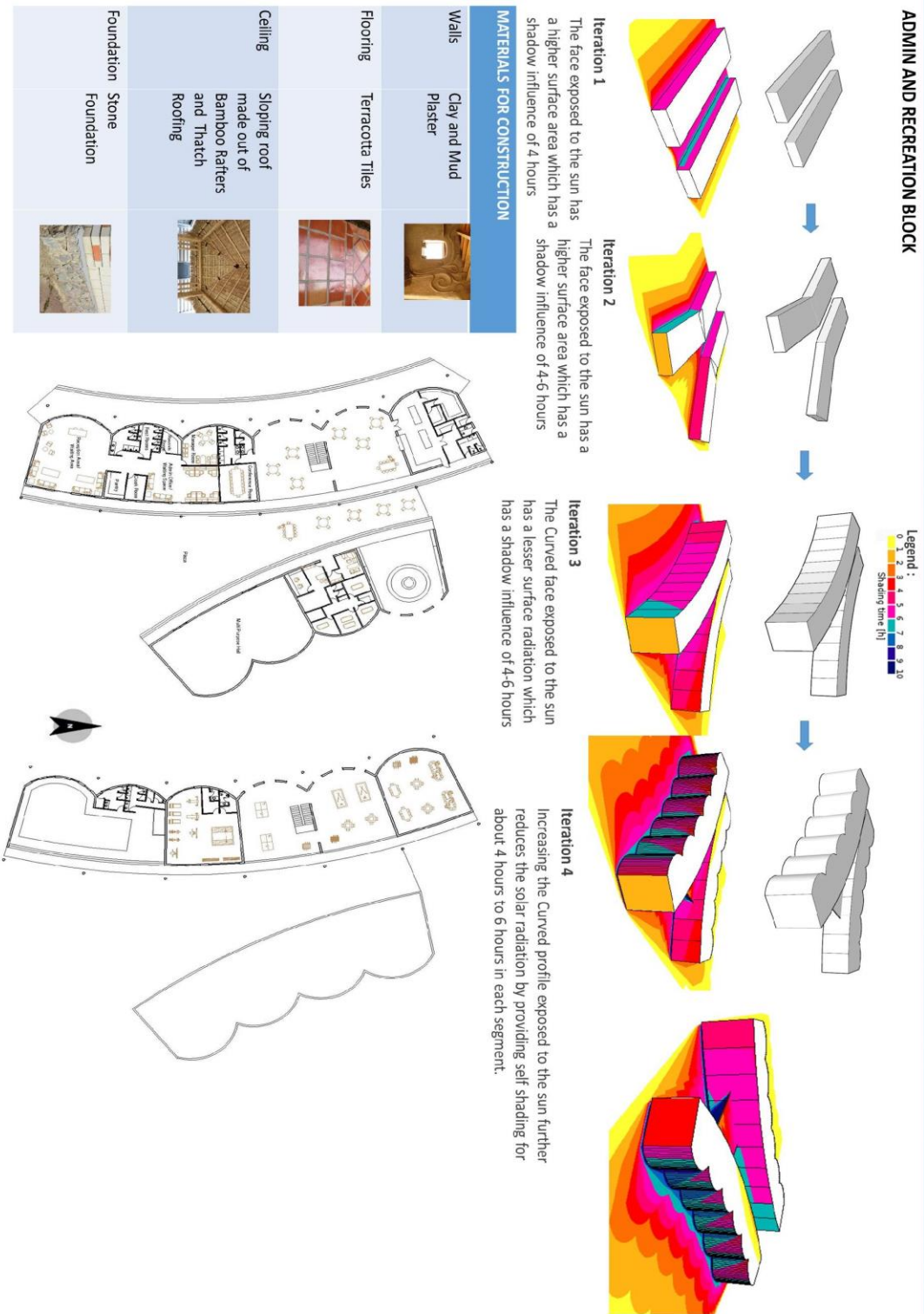
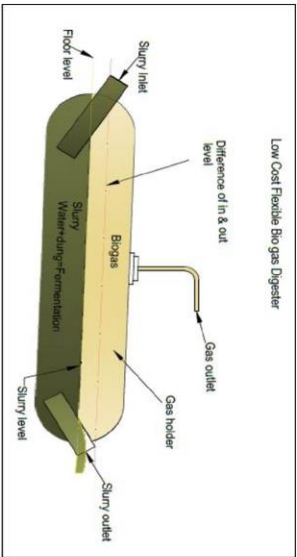


Fig 4.14 Admin Block

CALCULATIONS FOR ENERGY SAVINGS BIO GAS PLANT :



SECTION OF A BALLOON DIGESTER PLANT :



VIEW OF A BALLOON DIGESTER

Flexible Balloon Digester :
The balloon technology can recycle wastes like Man made, Animal made, Bio wastes (green or dry) with water with the help of gravity. Because of 8" dia inlet, very thick & hard solid agri wastes can also be induced into the plant.

The Released Gas is free of cost. The Plant can be operated fully automatic, semi-automatic or manual depending upon individual site situation. No pressure booster pump is required if reduction in gas pressure as we can place a sandbag on balloon.

Calculation :

The digester volume V_d , is determined on the basis of the chosen retention time R_t and the daily substrate input quantity S_d .

$$V_d = S_d * R_t \text{ [m}^3 = \text{m}^3/\text{day} \times \text{number of days}]$$

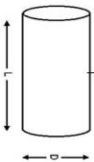
The digester must be sized for the least favorable season of the year. For a plant of simple design, the retention time should amount to at least 40 days.

The substrate input depends on how much water has to be added to the substrate in order to arrive at a solids content of 4-8%.

$$\text{Substrate input (Sd)} = \text{biomass (B)} + \text{water (W)} \text{ [m}^3/\text{d}]$$

For optimal biogas production, water must usually be added to the waste, and other feedstock put into the digester, the added water volume can be assumed to equal the waste volume (most biogas plant manuals recommend adding water to the waste in a ratio of 1:1).

$$V_p = \pi \left(\frac{D}{2}\right)^2 L$$



The Volume of a Balloon digester can be calculated using the formula,
Where,
 V_p – Volume of Digester
 D – Diameter
 L – Length of the digester.

Table 14: Estimated volume of a balloon digester by length and diameter

Diameter (m)	Length = 10 metres			Length = 15 metres			Length = 20 metres		
	Volume (m³)	Biogas (m³/day)	Produce (kg/day)	Volume (m³)	Biogas (m³/day)	Produce (kg/day)	Volume (m³)	Biogas (m³/day)	Produce (kg/day)
1.0	0.99	0.90	0.33	1.48	1.35	0.49	1.97	1.80	0.64
1.2	1.10	1.00	0.36	1.66	1.50	0.54	2.21	2.00	0.71
1.4	1.23	1.12	0.40	1.87	1.68	0.60	2.46	2.25	0.79
1.6	1.39	1.26	0.44	2.10	1.89	0.67	2.74	2.50	0.88
1.8	1.57	1.42	0.50	2.36	2.13	0.76	3.04	2.79	0.99
2.0	1.77	1.60	0.56	2.64	2.40	0.84	3.36	3.08	1.10
2.2	1.99	1.80	0.64	2.94	2.68	0.94	3.70	3.39	1.22
2.4	2.23	2.00	0.71	3.26	2.99	1.05	4.06	3.72	1.35
2.6	2.49	2.22	0.79	3.60	3.30	1.17	4.44	4.06	1.49
2.8	2.77	2.46	0.88	3.96	3.63	1.30	4.84	4.40	1.64
3.0	3.07	2.72	0.98	4.34	3.98	1.44	5.26	4.77	1.80

Source : (International Renewable Energy Agency (IRENA))

Calculation for The resort :

Discription	Quantity	Units
Per day Waste Generated	0.3	Kg/Day
No of Guests	60	
Total waste generated per day on site	18	Kg
1 cubic meter = 1000 kgs	1000	Kg
24 kgs to cubic meters =	0.018	cubic m
1/1000		
Water content to be added inside the digester 1:1 ratio	0.018	cubic m
plant capacity = (water quantity + slurry quantity) X Retention Days		
Retention days capacity is around 40 days for food waste (reference from web)		
Slurry Volume	0.036	cubic m
Retention Period	40	days
Required Bio Gas Plant Volume in cubic m	1.44	

Proposed Flexible Balloon Digester on site :
Site – 1.2 M X 2M
Digester Volume achieved – 1.7 cubic m
Gas storage volume – 0.57 cubic m
Daily gas production – 0.94 cubic m / per day



- 1 m³ of biogas = 0.66 MJ of methane
- 1 m³ of methane = 34 MJ of energy
- 1 m³ of biogas = 22 MJ of energy
- 1 m³/day of biogas = 8,064 MJ/year

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Fig 4.15 Bio Gas Plant

ELECTRICAL FIXTURES:

Product Info	Picture	Initial Performance (IEC Compliant)	Specs
Ceiling Points Brand - Pillips		Initial lumens (lm) 6000 lm Initial Efficacy (lm/W) 110 lm/W IEC CRI Color Temperature 3000 K IEC CRI Beam Angle 140°	Initial Input Power 53 W Initial Power Factor 0.95 Initial Power Consumption 53 W
Cove Lighting Strips Brand - Pillips		Initial lumens (lm) 6000 lm Initial Efficacy (lm/W) 110 lm/W IEC CRI Color Temperature 3000 K	IEC CRI Beam Angle 90° Initial Input Power 53 W Initial Power Factor 0.95 Initial Power Consumption 53 W
Down Lighting Brand - Pillips		Initial lumens (lm) 2000 lm Initial Efficacy (lm/W) 100 lm/W IEC CRI Color Temperature 3000 K	IEC CRI Beam Angle 120° Initial Input Power 20 W Initial Power Factor 0.95 Initial Power Consumption 20 W
Linear Lighting Brand - Pillips		Initial lumens (lm) 3000 lm Initial Efficacy (lm/W) 100 lm/W IEC CRI Color Temperature 3000 K	IEC CRI Beam Angle 120° Initial Input Power 30 W Initial Power Factor 0.95 Initial Power Consumption 30 W
Wall Points Brand - Pillips		Initial lumens (lm) 2000 lm Initial Efficacy (lm/W) 100 lm/W IEC CRI Color Temperature 3000 K	IEC CRI Beam Angle 120° Initial Input Power 20 W Initial Power Factor 0.95 Initial Power Consumption 20 W
Fan Brand - Luminous		Initial lumens (lm) 2000 lm Initial Efficacy (lm/W) 100 lm/W IEC CRI Color Temperature 3000 K	IEC CRI Beam Angle 120° Initial Input Power 20 W Initial Power Factor 0.95 Initial Power Consumption 20 W

Consolidated Energy Required

Consolidated Energy Required			
Typology	Numbers	Required	Total
Admin Block	1	6888	6888
Dormitory	1	227.5	227.5
Sun Room	10	183.5	1835
Cottage	10	180.5	1805
Log House	10	180.5	1805
Total Energy Required per Hour (w/rt in Watt)			12510.5

Energy Required in Watt hours	1250.5	12	150.126
Energy Required in KWh	Watt/1000		150.126

Proposed solar panel capacity	440	Watts
Total Power Required	150126	Watts
Total Solar Panels Required	Power Required / Solar Panel Power	341,195-645
Cost savings		
Price of 1 unit of current in Kerala	Energy generated by Solar Panel	472896.9
315	150126	

A total of 340 Solar panels of 440 Watts each is required to power the entire resort.

Area Required for The Solar Power Plant	Length	Breath	Area of 1 Panel (in sqm)
	2.05	0.99	2.0255
Area of 340 Panels	2.0295	341.1954545	652.456175
	700 sqm		
Area Provided For Parking on site			

Total area required for the solar plant is about 690 sqm.

Since the power plant is proposed over the car parking area, the area proposed for the car parking comes around 700sqm and therefore satisfying the space requirement.

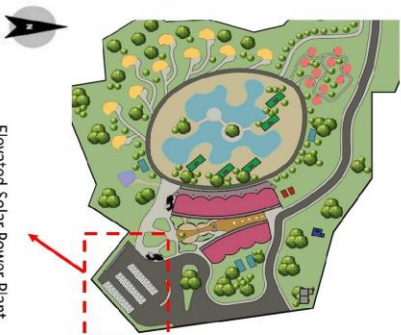


Loom Solar

Output Power
440 W.



Panel Type	Monocrystalline Solar
Rated Power	400 Watts
Efficiency	22.5%
Operating Voltage	48VDC
Panel Technology	MonofEFC
Manufacturer warranty	10-year on manufacturing defects
Performance Warranty	25 Years
Additional Features	5th Generation Monocrystalline Solar Cells (PID FREE) from Germany Cell Conversion efficiency > 22% Compliance with IEC standards



**Elevated Solar Power Plant
PART SITE PLAN**

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Fig 4.17 Electricity Load Calculations

CHAPTER 5

INFERENCE OF THE RESEARCH

Table 5.1: Parameters of Regenerative Architecture Implemented - 1

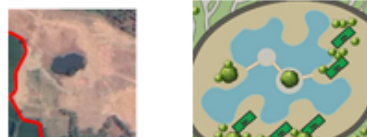
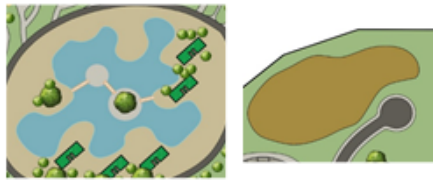
SNO	Parameters of Regenerative Architecture	Identified on site	On site References to support the theory
1	Energy Consumption and Saving Measures	Having a Solar power plant over the parking space which provides 150Kwh of power to sustain the entire resort. And saving space by elevating it	 Solar power panels of 150KWh is provided on site at the parking area
		Grey water treatment plant to recycle and reuse the water resource.	 Sewage treatment plant of capacity 20,000 Litres is provided on site
		Use of Low flow water fixtures to reduce Litres of water used per day	 Low Flow Fixtures are provided for all toilet taps
2	Sustainable site Developments	Use of Mud for construction which does not invade the local habitat	 Conserving the top soil and only mud structures all around the site
		Conserving the Top Soil layer as for mud construction we only use soil below 600 mm in depth	
		Conserving the water body that was already existing in the site without disturbing the water drain direction	 Recreating the existing water body
3	Nature and Man made structure Symbiosis	- This Criteria is hypothetical as nature and man made structure cannot function in a symbiotic pattern. - But we can say that this one satisfies to a certain extent as the structure which is proposed is entirely out of mud that can self sustain life even after it is demolished without any construction debris or any harmful non recyclable material. - Since there is also a new rainwater harvesting pond the eco system in this area will improve overtime and some kind of symbiosis can be seen.	

Table 5.1: Parameters of Regenerative Architecture Implemented - 2

4	Increasing Bio Diversity	•Conserving the water body that was already existing in the site without disturbing the water drain direction •Since the top Soil is retained the fertility of the soil is not compromised •Planting of native species trees like Peepal, Neem, Coconut, Kongini shrub in the empty site can increases the scope of bio diversity	 Endosing and increasing the count of native species without any invading species
5	Circular Economy	•Incorporating a Bio Gas plant inside the site. It serves purpose for the conversion of Organic waste into methane which can be used as a cooking gas for kitchen. The total energy generated is 1.45 cubic m per day •All the Organic waste and agricultural waste from the surrounding can be feeded inside this bio gas plant and slurry can be used as a manure and thereby making this as a zero waste output process. •On site Solar Power station reduces the need for electricity from the power grid on most of the months. This electricity can also be supported by the biogas plant within the site as it can produce about 13.65 KWh of energy if it is used for electricity purpose.	 Here Organic waste is the raw material for the bio gas plant and the resultant output slurry is the raw material for the secondary input in the form of manure
6	Permaculture Architectural Designing	•Permaculture design is a multi-faced and environmentally hamonious, fully integrated method for creating designs for human-focused landscapes. •The local environment of a permaculture design will be capable of supplying many essential necessities of a human family unit or larger community efficiently like food and water •Inter-connecting all elements in a system by successful alignment of the outputs of one element to the inputs of a second element with high levels of efficiency and no waste.	 Understanding the working of site and incorporating solutions to benefit the living beings and the environment
7	Reduced Carbon Foot Print	•The Use of natural materials from the construction site itself reduces the embodied energy required for construction •Transport being the main consumer of embodied energy is nullified as everything required to build is inside the site itself. •Recycling of waste materials and production of required electricity within the site makes the site non dependant on power grid. •Construction and demolition waste is not going to be a issue if the structure is going to be demolished at a later stage.	

5.1 INFERENCE:

This thesis is an attempt to make the resort function as Regenerative design. The existing proposal can be further improved to a better design by focusing on various other parameters as well. Regenerative design is about thinking ahead, where one must design with the future in mind. It contradicts with sustainably designed buildings, which are based on the concept of only using the minimum resources you need, regenerative buildings are designed and operated to reverse damage and have a net-positive impact on the

environment. Buildings as trees, and cities as forests propose an evolution of modernist architecture paradigms from mechanical to organic and that changes everything. Where architecture is designed through regenerative processes that mimic ecological interrelationship.

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