# Energy Efficient Health Centres

# 2019

APRIL 3

**SELCO FOUNDATION**

**Built Environment**

# ENERGY EFFICIENT HEALTH SUB-CENTER

*Case Study on Low Energy Consumptive Health Spaces*

### What are low energy spaces?

Shelters that have ample amount of natural lighting, cross ventilation or air circulation and are well insulated from the heat and cold to promote thermal comfort for habitation indoors are inherently low in their consumption of energy.

### How do you achieve reduced energy consumption through built spaces?

A. Efficient Spatial Design

*Planning, shape, orientation and shading – to limit or enhance solar heat gain and capture air movements of the micro climate*

B. Material and Insulation

*Treating the envelope and building with materials with appropriate U-value in response to local climatic conditions*

C. Design of Fenestrations

*Size, location, type and accessibility of doors, windows, ventilators etc*

Additional aspects that were considered to provide a holistic health centre design;

- Optimising functionality of spaces
- Adaptivity to local social contexts i.e. typologies of rural, urban and tribal communities with specific health care requirements
- Physiological and physical benefits to occupants of the space (productivity, wellbeing) i.e. patients, nurses, visitors etc

> ***"Improved thermal comfort and reduced energy consumptions for health centers across geographies and climatic conditions"***

## Introduction

The Health Sub-centre is the peripheral outpost and the first hope of healthcare for people living in remote areas. It fulfils the basic primary and quality health care needs of the families surviving in difficult circumstances in the remote areas.

The centres are usually manned by an Auxiliary Nurse Midwife (ANM) whose focus is on primitive and preventive healthcare services, and to act as a referral to the Primary Healthcare Center (PHC) for curative services.

Several factors contribute towards underutilization of sub centres some of them are: -

- Lack of appropriate infrastructure
- Erratic power cuts and poor quality of power from the grid (Decreased life of equipment)
- Inadequate Human Resources at various centres

## Current Healthcare and Energy scenario of Sub-centres*

- 25 % of Health Sub-Centers (SC) out of 1.5 Lakh have no electricity access
- 55% (84000 HSCs) have no quarters for ANMs. Even where ANM quarters exist, in 35% (30000) of the HSCs, the ANMs are actually not staying there.
- Out of the functioning SCs, close to 40000 of them are yet to construct own buildings.
- Beyond these, there is a 35000 shortfall in the number of HSCs.

## Current Built Environment scenario of Sub-centres nationally

- Inadequate natural lighting, cross ventilation and thermal comfort for activities and functions which results in high dependence on electricity - lights and fans.
- Poor space management leads to underutilized/ dead spaces
- Construction in RCC with no weatherproofing that respond poorly to most climatic conditions and geographies in India
- No adequate sun-shading/ protection for structure
- Not accessible to mobility challenged patients. Toilets are not mobility friendly
- Lack of or dilapidated residential units for ANMs. No privacy/ security for ANMs

**Source of Information*: ***Rural Health Statistics 2017, National Health Mission – Government of India***

*Health Sub-Centre in North Karnataka, India*

## Sub-Centre Layout Plan as per IPHS (Standardised)

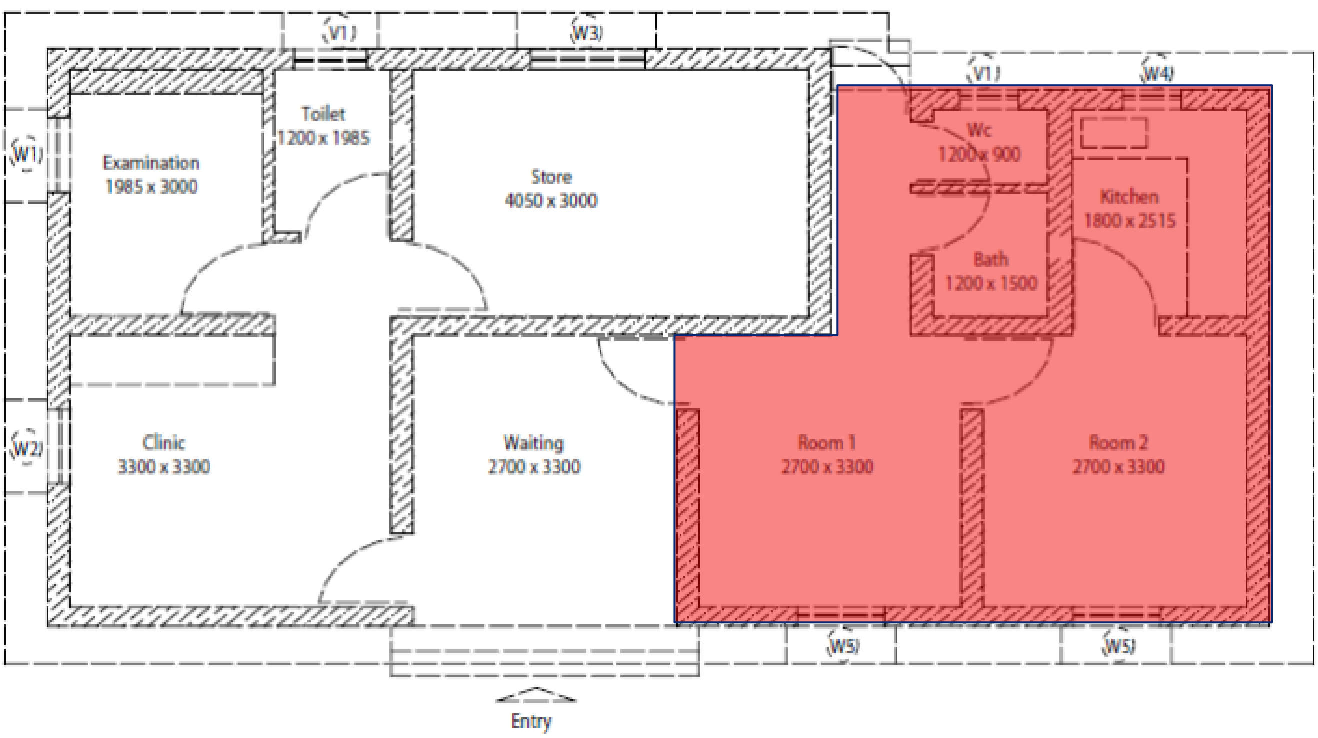


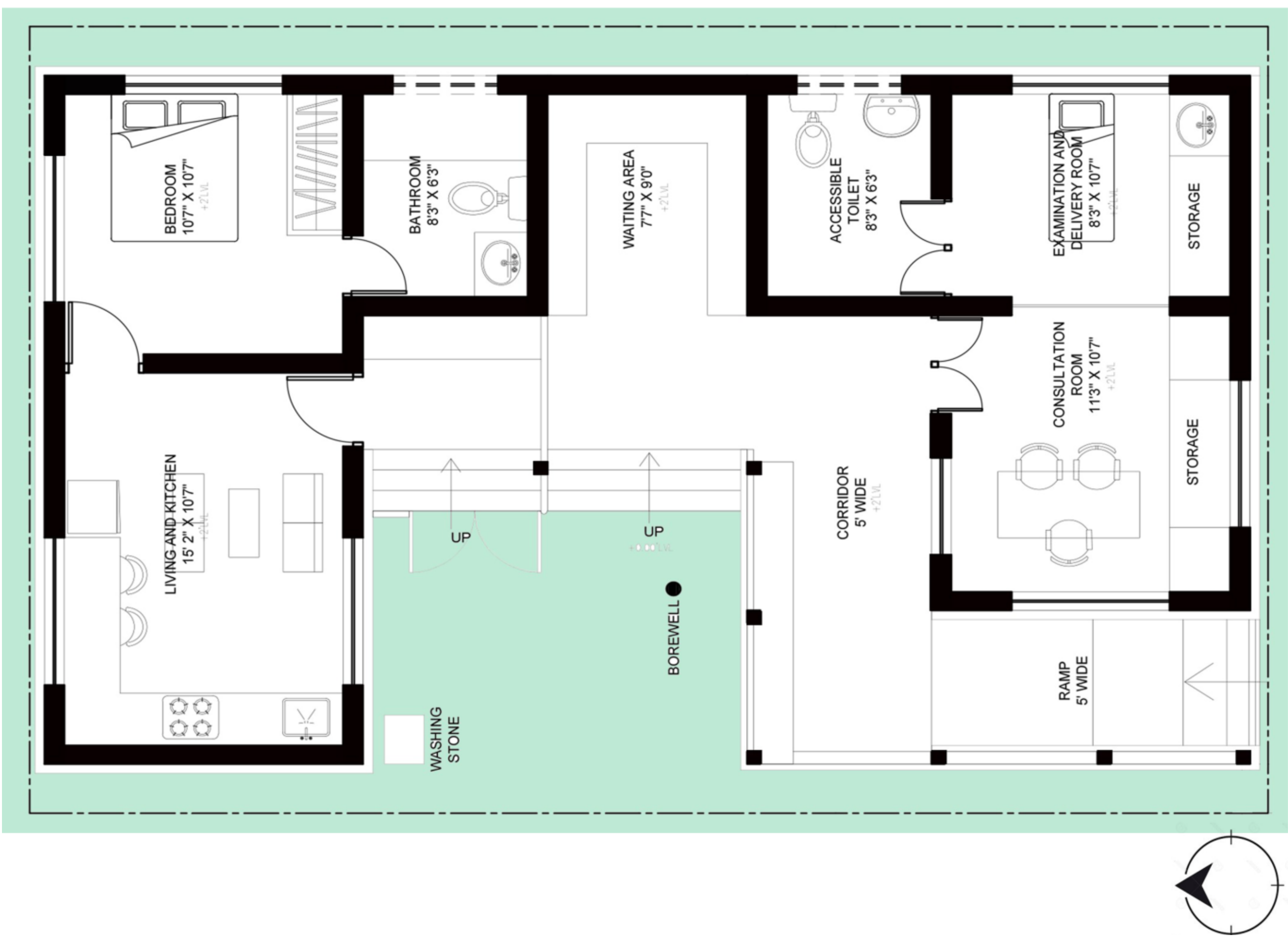

*Image reference: IPHS Standards for Health Sub-centres*

*__SELCO Foundation__ in partnership with __Karuna Trust__, designed and built two model Health Sub-Centres catering to two different geographies and climatic conditions, Keba in Arunachal Pradesh and Gumballi in Karnataka. The two sites are contrastingly different in their patient backgrounds and health services provided. Following is the detailed analysis on the strategies for design in response to local climate for energy efficient, thermally comfortable spaces.*

## Type A

## Sub-Centre Plans without Delivery Service – Gumballi, Karnataka

*Total area = 1100 sq.ft | Maximum temperature - 39 °C, Driest month precipitation – 3mm | Hot-dry Climate*




*Schematic Layout of Y.K Mole Health Sub-Centre at Gumballi, Karnataka*

*Completed Y.K Mole Health Sub-Centre at Gumballi, Karnataka | March 2019*

### Climatic Conditions and User Behavior

| | | | |
|---|---|---|---|
| Location: | **YK Mole**, Karnataka | Temperature: | **39**℃ to **19**℃ |
| Climate: | **Hot and Dry** | Wind direction: | SW and NE |
| Building Gross Area: | **1092** sq. ft. | Building age: | constructed March 2019 |
| Occupancy: | **1** ANM | Building Use: | Health Care/ Residential |
| Number of Floors: | Ground only | Number of rooms: | 6 |

| | |
|---|---|
| Day time occupancy (6am to 5pm): | Kitchen areas(R) |
| | Examination and Clinic (SC) |
| | Waiting areas (SC) |
| Night time occupancy (5pm to 6am): | Bedrooms and Living room(R) |

## Built Design Analysis

### A. Efficient Spatial Design

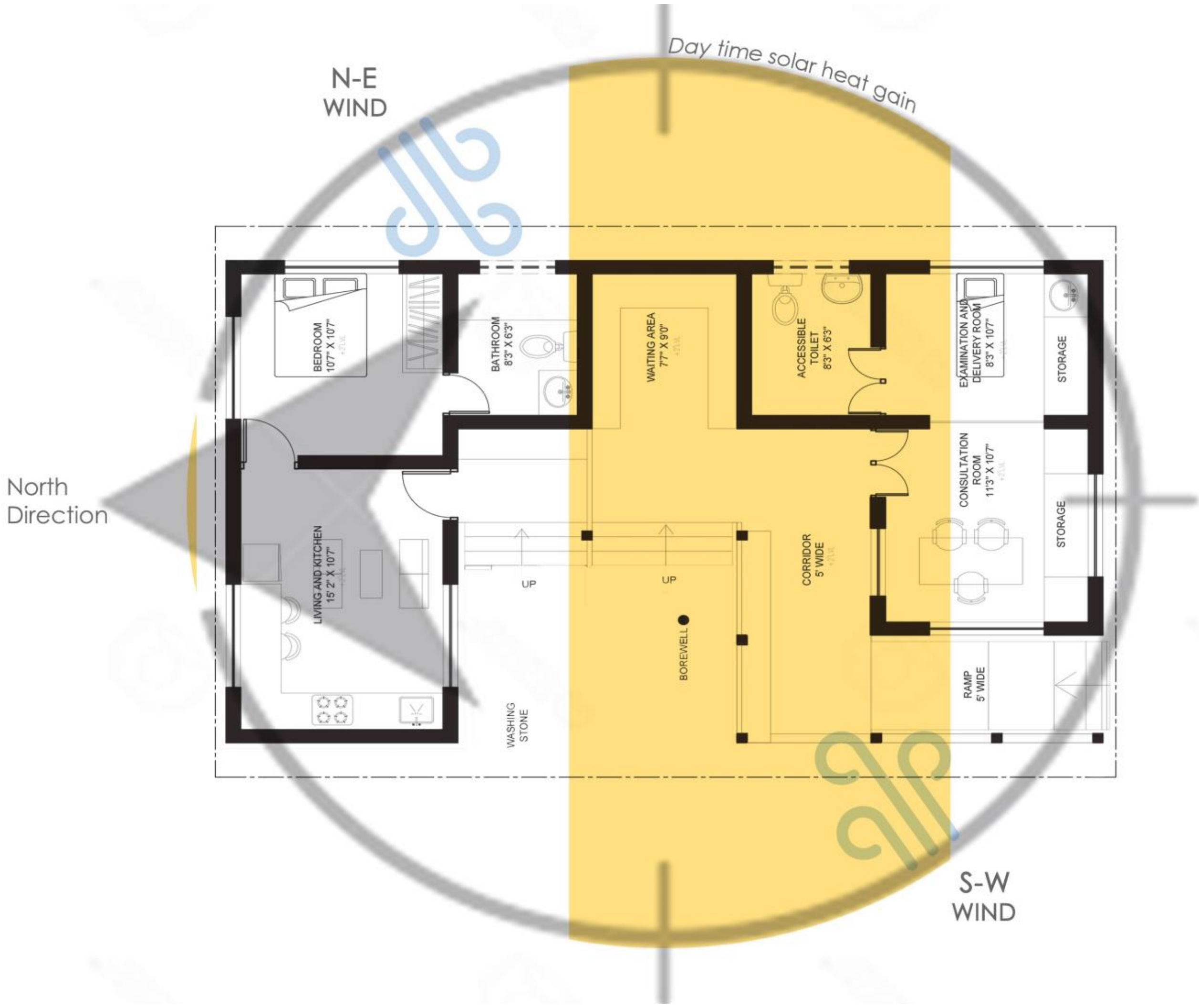
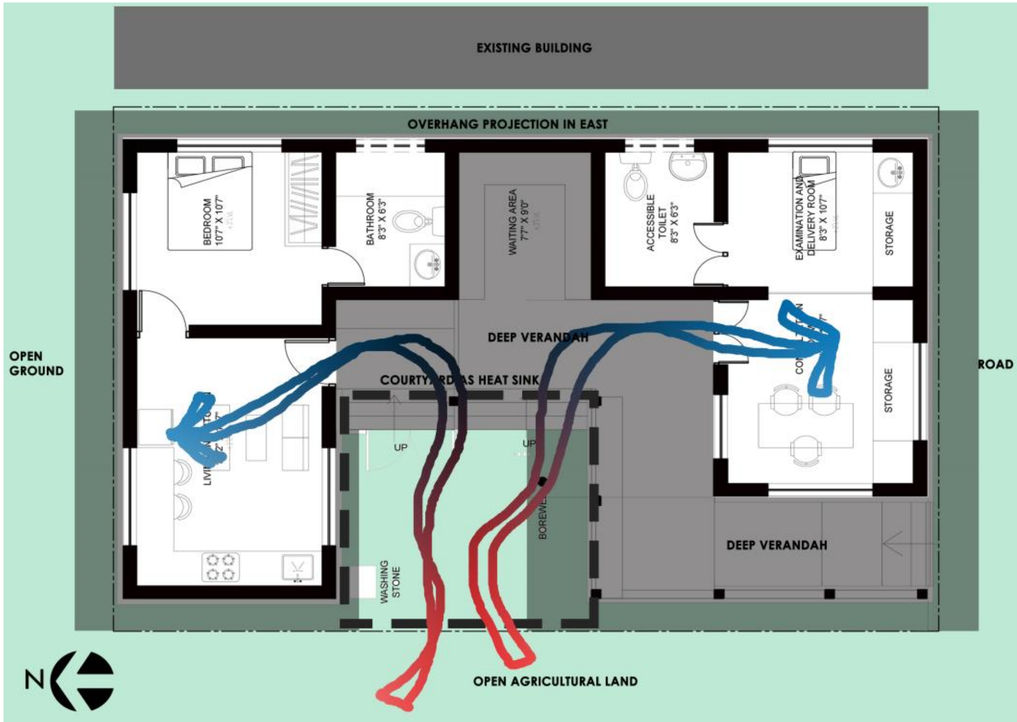



*fig (A) Spatial layout and orientation*

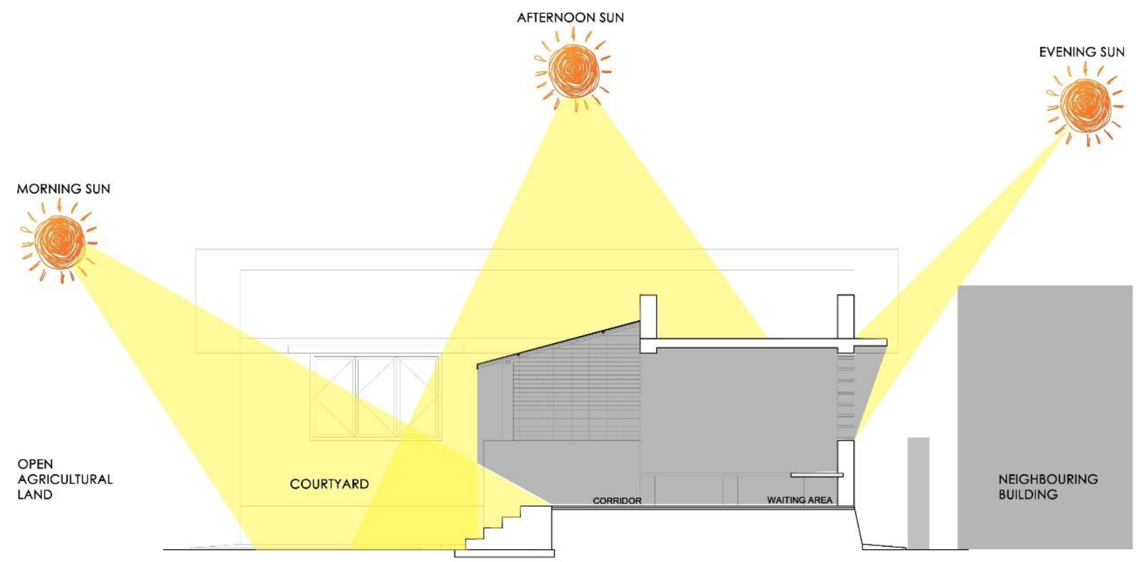
1. Layout plan - Asymmetrical C-shaped with Central Courtyard [*fig(A)]*
   - Shorter façade facing south to reduce solar heat gain from 11.30am to 2.30pm
   - Improves cross ventilation especially for the rooms on the north and south edges, as the walls are facing externally and aligned to the wind direction.
   - The courtyard acts as a heat sink which creates higher pressure area due to heat and allows hot air to escape [*fig(B)]*
   - The overhang projections on the south façade, were not implemented as per design and might not block out solar gain as designed.




*fig(B) Courtyard and Shaded Region*

2. Deep Verandah of 6ft to 8ft
    - Recessing the windows from the wall outer edge and building chajjas of x length to prevent entry of direct sunlight through the window.
    - Blocking solar radiation by constructing large overhangs on the east façade and adding an exterior shading system promotes cool air entering the windows during the summer[*fig(d)*]
    - During the winters, the low altitude of the winter sun warms the facades and thermal lag resulting in warmer nights indoors.

*Image (c)Verandah*




*fig(d) Solar Gain throughout the day*


*fig (E &F) Recessed Window and Chajja*

### B. Material and Insulation

The main characteristics of the building envelope are highly-efficient walls and roof which allow delayed heat to transfer into the building. Structure designed has high thermal resistance, especially important in the coldest and hottest month.

**Construction type**

- Insulated Roofing using Bison Board and Color coated sheets having air cavity in between as an insulation and double roofing which delays heat gain through roofing [*fig(h))*

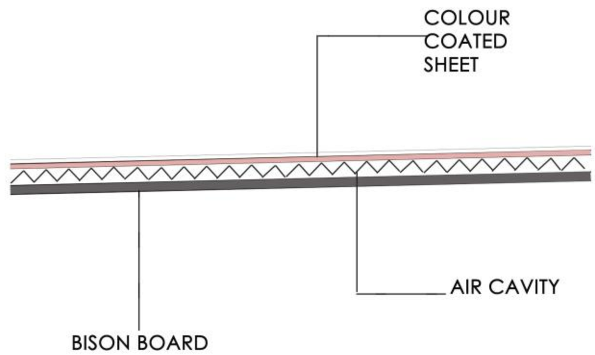
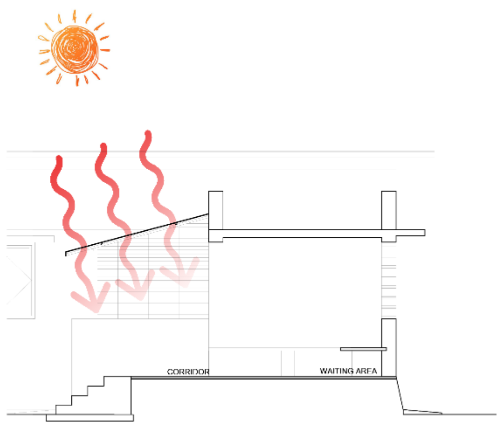



*fig ( G) Load Bearing Wall construction,(H))Roof insulation detail*

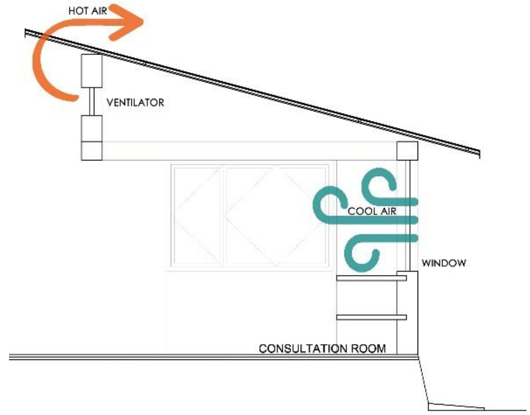



*fig(I) Solar Heat Gain through roofing surface*

### C. Design of Fenestrations

The window wall ratio was designed for 22.5 percent, nearly 75 percent of the indoor spaces are lit by natural light, hence saves energy during much of the day.

- Due to the strategic placement of windows and ventilators which helps in better cross ventilation and thermal insulation, different spaces are able to achieve required thermal comfort. For example: Spatial arrangement of windows on perpendicular walls and facing the prevailing wind direction improves cross ventilation; placement of  ventilators above windows can create stack ventilation and hence improving indoor climate.



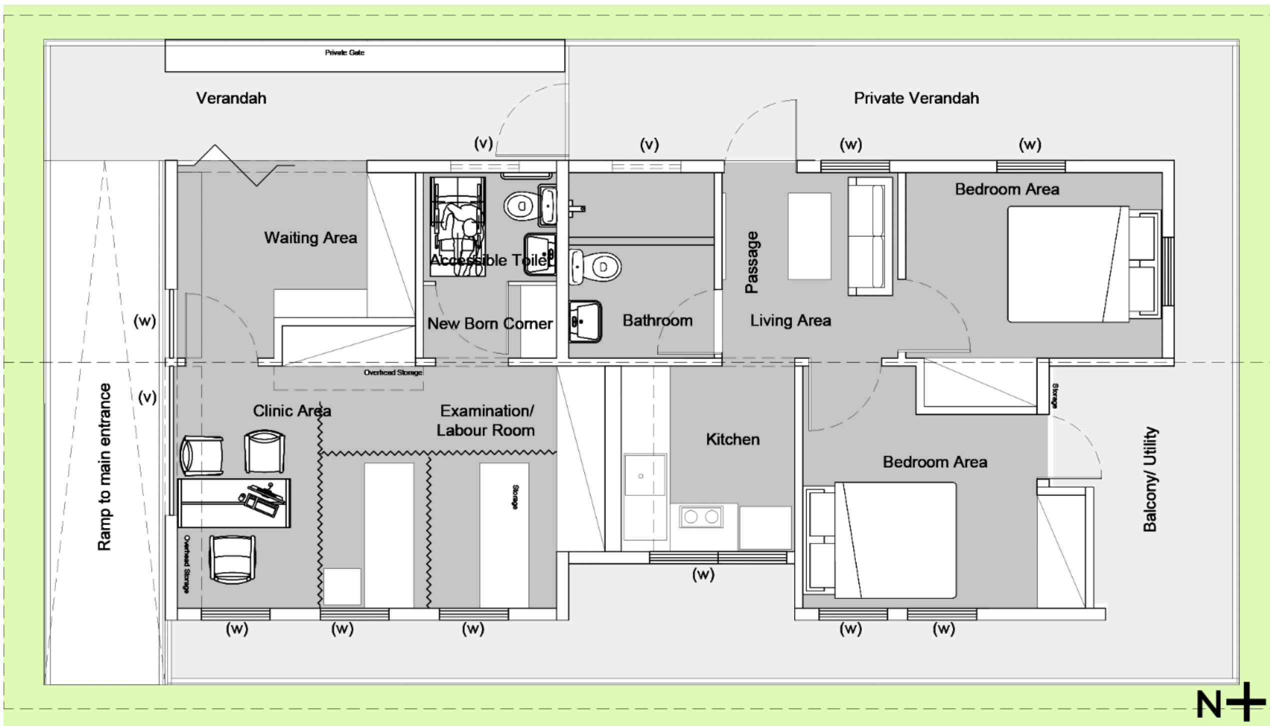

*fig(J & K) Ventilators and air gaps in the roof for hot air to escape*

*fig (L)Lighting readings in each space (2ND march 2019 @11:50pm)*

## Type B

## Sub-Centre Plans with Delivery Service – Keba, Arunachal Pradesh

*Total area = 1400 sq.ft | Avg. Temp Summer - 28 °C, Winter - 16 °C, Avg. Humidity – 45% | Warm and Cold*




*Schematic Layout of Keba Health Sub-Centre at Arunachal Pradesh*

*Completed Keba Health Sub-Centre at Arunachal Pradesh | November 2018*

### Climatic Conditions and User Behaviour

Location: **Keba**, Arunachal Pradesh
Climate: **Warm and Cold**
Building Gross Area: **1,400** sqft
Occupancy: **2** ANMs
Number of Floors: Ground only

Temperature Range: **28**°*C* to **16**°*C (45% Humidity)*
Wind direction: SW and NE
Building age: constructed January 2018
Building Use: Health Care/ Residential
Number of rooms: 8

Day time occupancy (6am to 5pm): Kitchen areas(R)
Examination/ Delivery room (SC)
Waiting areas (SC)
Night time occupancy (5pm to 6am): Bedrooms and Living room(R)

### Built Design Analysis

#### D. Efficient Spatial Design

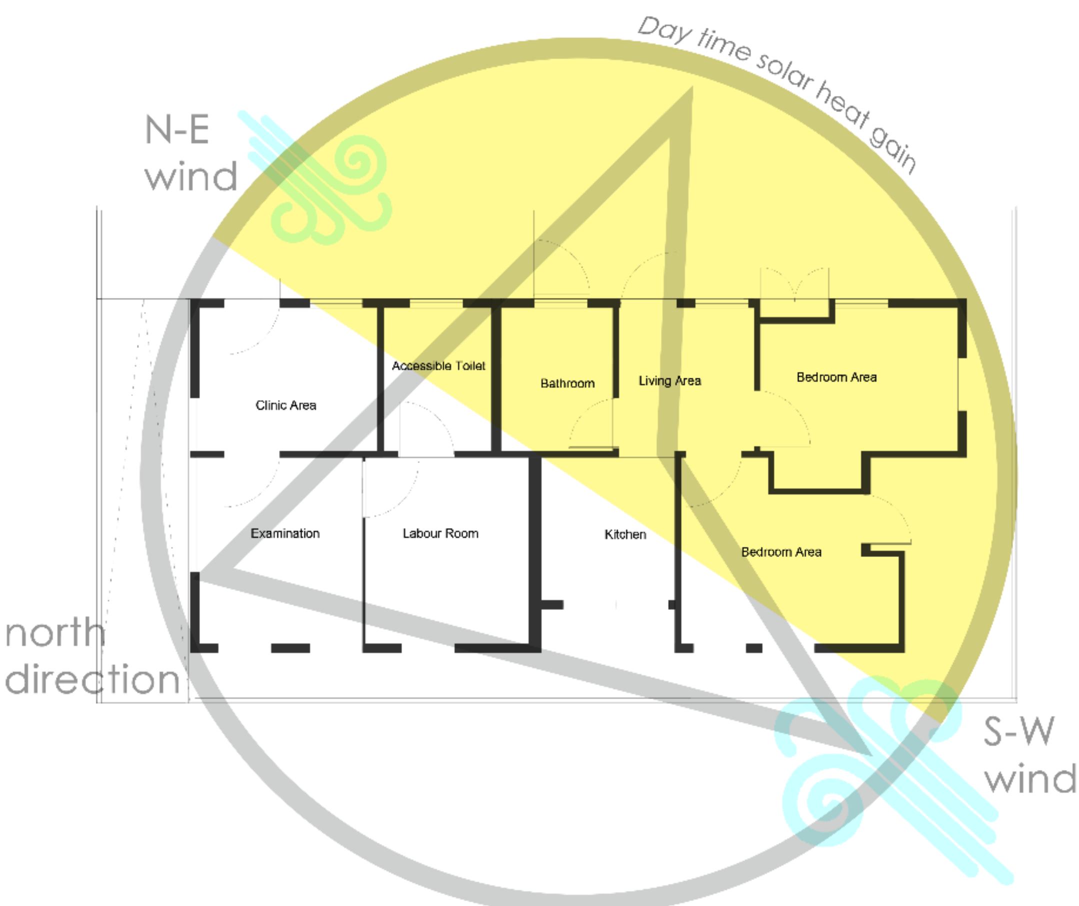



*fig (M) Spatial layout and orientation*

1. Linear layout plan *[fig (M)]*
    - Shorter façade facing south to reduce solar heat gain from 11.30am to 2.30pm
    - Improves cross ventilation especially for the rooms on the north and south edges as the walls are all external and aligned with the wind direction

2. Deep Verandah of 6ft to 8ft *[fig (N)]*
    - Recessing the windows from the building edge to prevent entry of direct sunlight through the windows
    - Blocking solar radiation by constructing large overhangs on the east and south façade and adding an exterior shading system promotes cool air entering the windows during the summer.
    - During the winters, the low altitude of the winter sun warms the facades

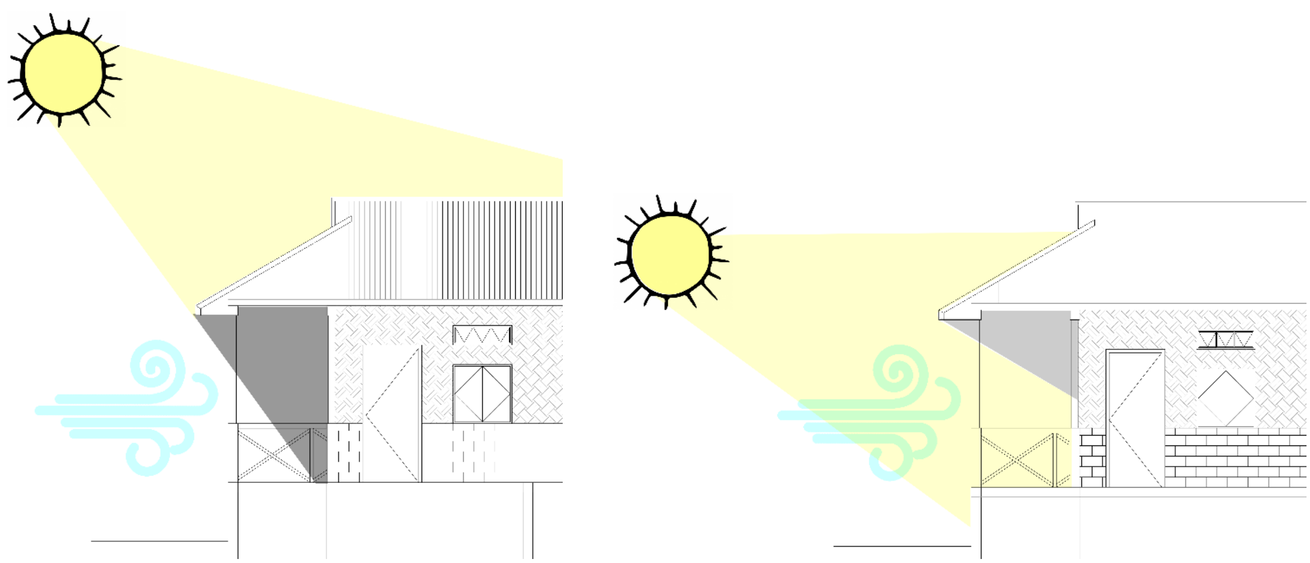


*fig (N) Summer and winter solar gain diagram*

**E. Material and Insulation**

The main characteristics of the building envelope are highly-efficient walls and roof which allow less heat to transfer into the building. Structure designed has high thermal resistance, especially important in the coldest and hottest month.

**Construction type**

- Composite with (in-situ) Load bearing Cement Blocks walls (for delivery room and toilets only)
- Timber Framework and Bamboo in-fills walls

*Image (P), (Q), (R)*

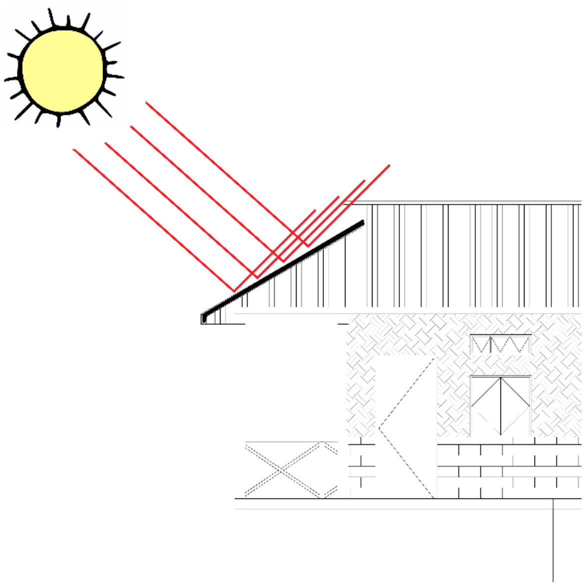


*fig (S) Solar reflective roofing surfaces*

Notes:
_Masons local to Keba were used in the construction of the centre.
_Materials were procured from the local villages or from the nearest town of Pasighat
_Local skill and knowledge of construction and design principles for increased thermal comfort were adapted together to achieve high efficiency of spaces and controlling overall cost of construction.

*White roof that allows 40 percent less heat into the building than a conventional RCC slab but couldn't be implemented in Keba.

### F. Design of Fenestrations

The window wall ratio was designed for 22.5 percent, nearly 75 percent of the space is lit by natural light and allows for the lights to be turned off, saving energy during much of the day

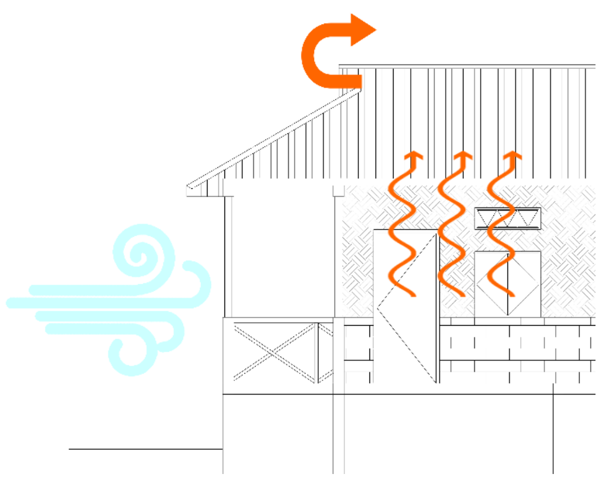


*fig (T) Ventilators and air gaps in the roof for hot air to escape*

## Improved Efficiency in Health Sub-centres

The health sub-centers energy performance in geographies and climatic conditions similar to Arunachal Pradesh and to Karnataka were compared to SELCO Model Sub-centres.

It was noted in most health sub-centers; (i) *Inefficient Lighting Fixtures and high energy consumptive Fans* were used. For sub-centers of similar functions and spatial requirements, the following were consumptive ranges

| | Type A<br>Gumballi, Karnataka | Type B<br>Keba, Arunachal Pradesh |
|---|---|---|
| Scenario A – High consumptive fixtures without Built Environment solutions | = 1.76 kWh<br>= 2.40 kWh | = 1.90 kWh<br>= 3.00 kWh |
| Scenario B – Efficient fixtures without Built Environment solutions | = 0.32 kWh<br>= 0.57 kWh | = 1.00 kWh<br>= 1.60 kWh |
| Scenario C - Efficient fixtures ***with*** Built Environment solutions i.e. Model Health Sub-centres | = 0.15 kWh<br>= 0.32 kWh | = 0.40 kWh<br>= 0.45 kWh |
| Energy Efficiency due to improved natural light (Scenario A vs. Scenario C) | 91% | 79% |
| Energy Efficiency due to improved air circulation (Scenario A vs. Scenario C) | 87% | 85% |

**Energy Efficiency in Healthcare Spaces**
**Health and Wellness Sub-centres**

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