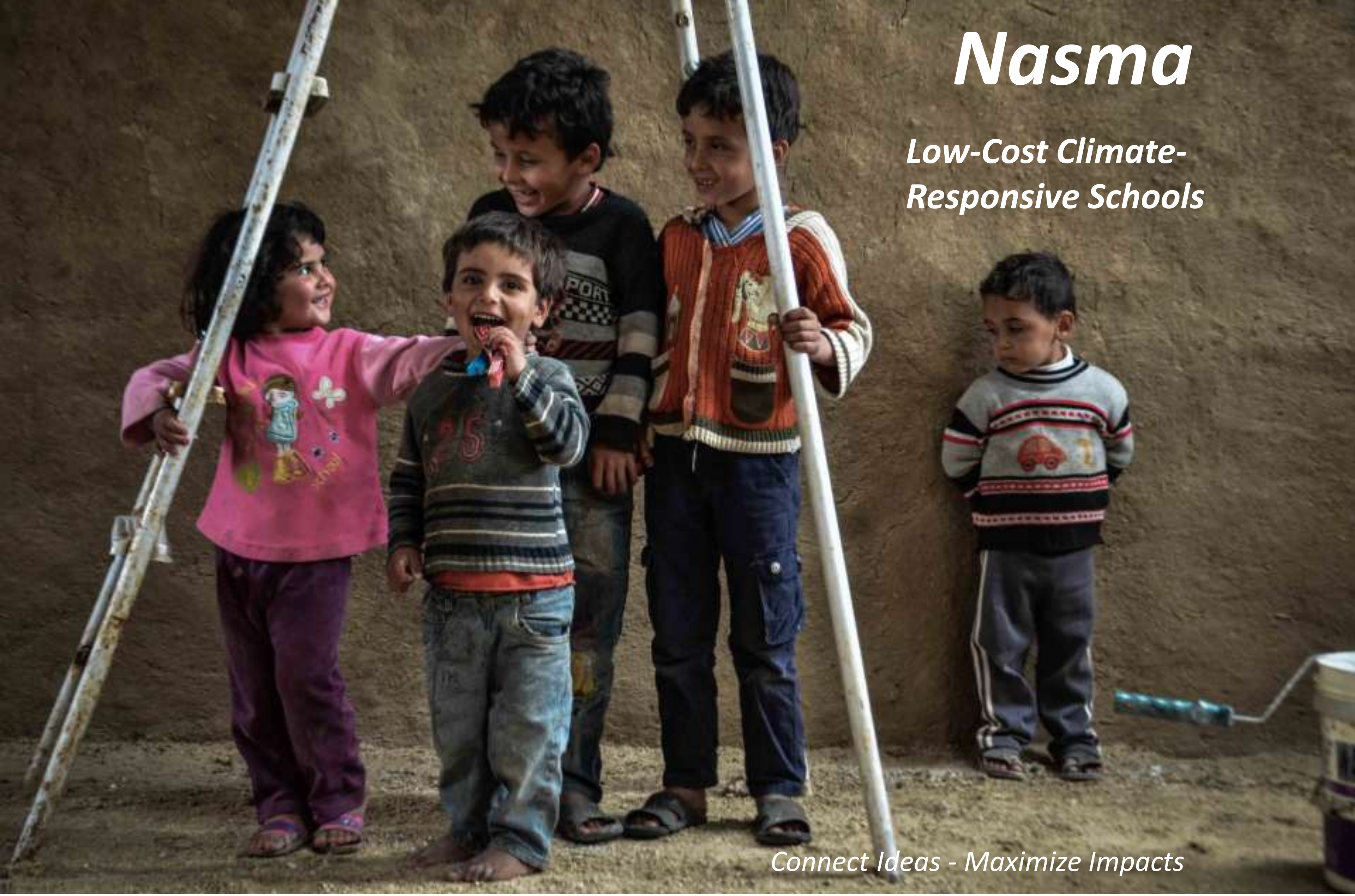


# *Nasma*

## *Low-Cost Climate-Responsive Schools*

*Connect Ideas - Maximize Impacts*


**Najjar & Najjar Architects**

**Transsolar / Climate Engineering**

# Presentation Outline

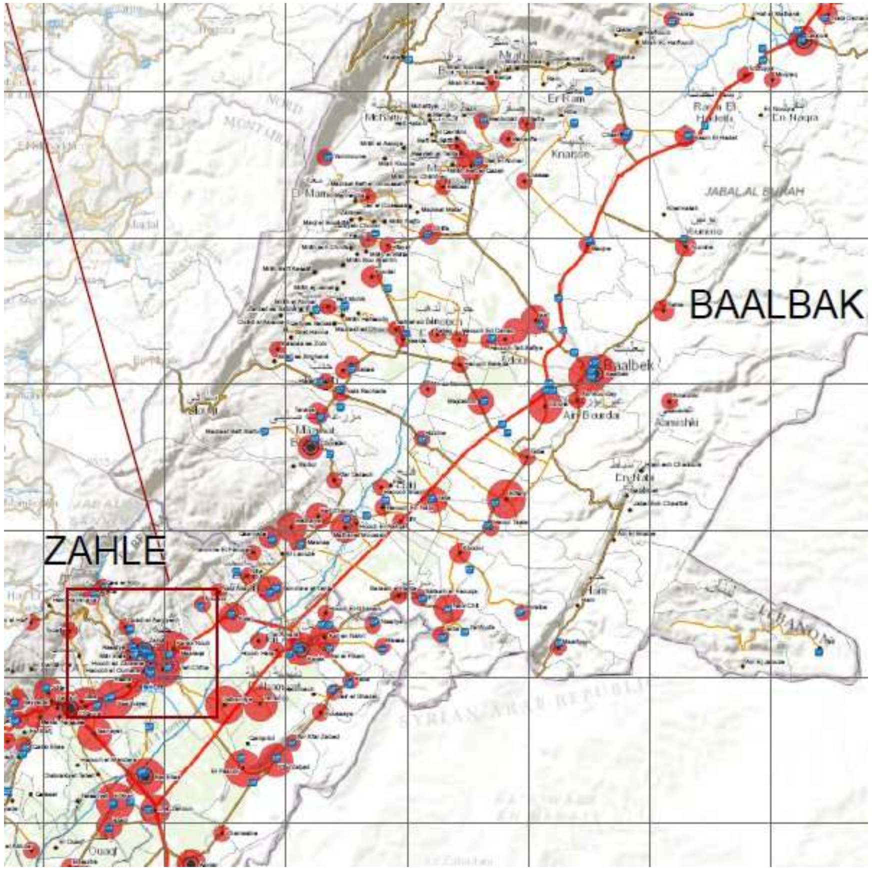
I. Survey

II. Research & Design

III. Implementation

# I. Survey

Parameters relevant to learning environments of Refugee Schools in the Bekaa




-**Temperature & Radiation**

-**Air Quality**

-**Light Conditions**

-**Acoustic Quality**

-**Environmental Impact**

-**Project Goals**

# Temperature and Radiation

Cold and hot temperatures in summer and winter challenge a healthy learning environment, often leading to cancellation of classes. Conventional heating and cooling devices are often not efficient, costly and rarely available.

# Air Quality


Confined spaces of refugee schools often lack proper ventilation which increases the $CO_2$ emission in classrooms drastically. Exposure to $CO_2$ can result in drowsiness, eye irritation, and inability to concentrate. Children often leave their classroom due to the poor ventilation.

## Light Conditions

Most refugees classrooms have poor light conditions. Darkness and glare in classrooms have a negative impact on the learning environment.

## Acoustic Conditions

Separate classrooms are mostly divided by fabric sheets or light panels which provides no sound insulation. Students and teachers are often distracted from neighboring classrooms.

# Environmental Impact


Ground water pollution damages eco-systems and contaminates the food chain.

Invasive construction causes damage to agricultural land.

# Project Goals

## Good Learning Conditions

Visual comfort

Air comfort

Thermal comfort

Acoustic comfort

## Environmental Friendly

Local materials

Small footprint

Low energy

## Sustainability

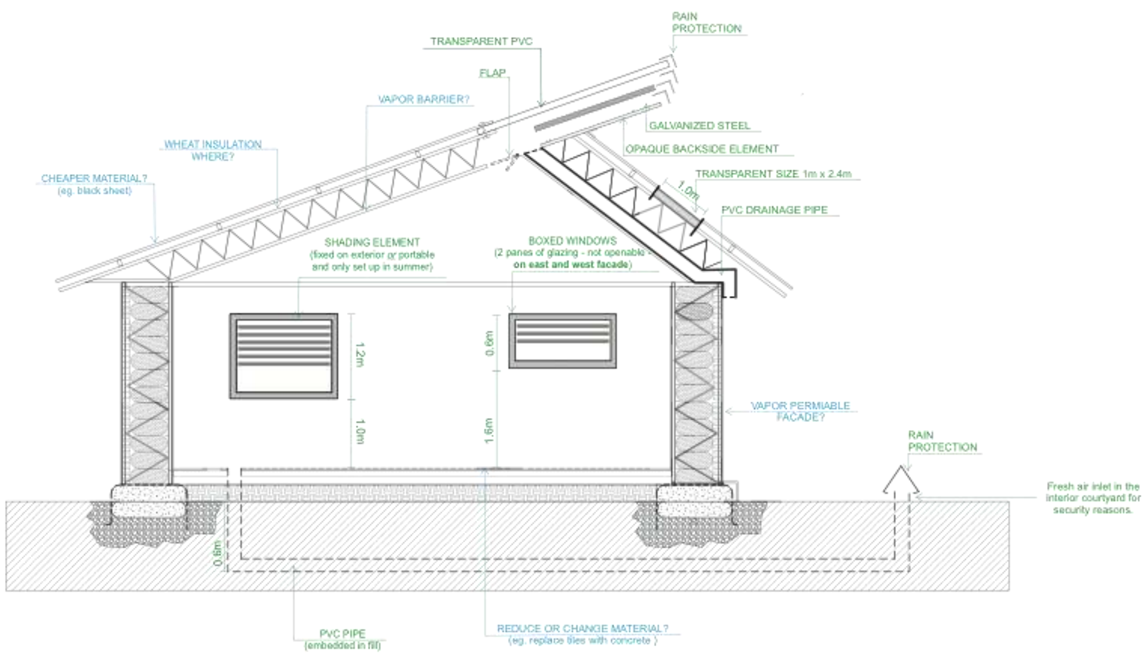
Re-usable materials

Re-locatable

Local materials

Participatory

# II. Design & Research




-Site climate

-Design strategy

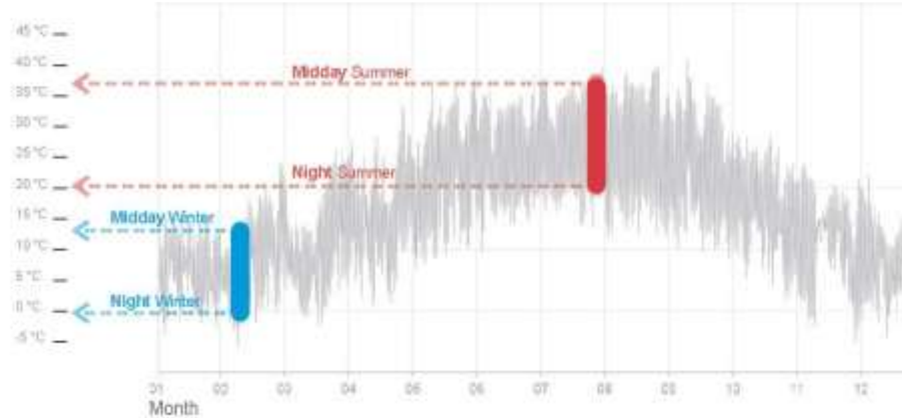
-Thermal simulations

-Daylight simulations

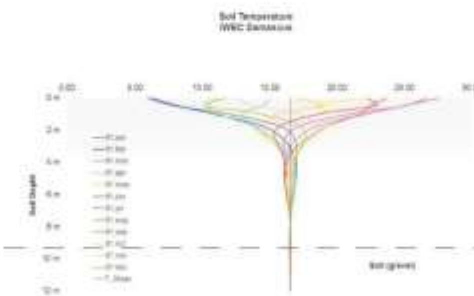
-Materials & Assemblage

- Passive strategies

# Site Climate

Out-door temperature in Bekaa Valley



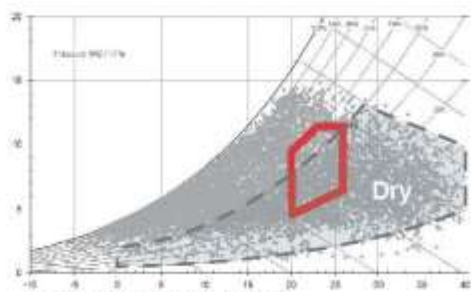
The prvialing winds direction is from south-west.

Cold winter wind comes maily from North

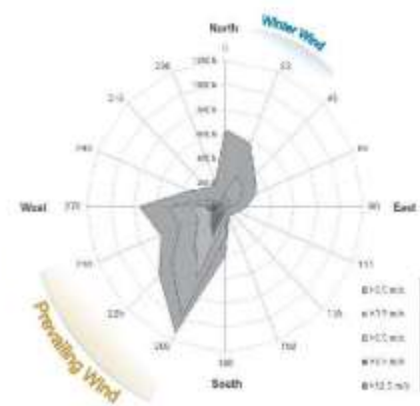

Located in Beakaa Valley, in Lebanon, neighboring to the Syrian borders.

In extreme summer day temperature ranges from 37°C at daytime to 21°C at night time

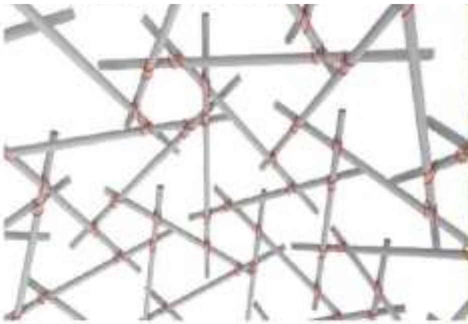
In extreme Winter day temperature ranges from 13°C at day time to -3°C at night



Out-door temperature and Humidity in Bekaa Valley



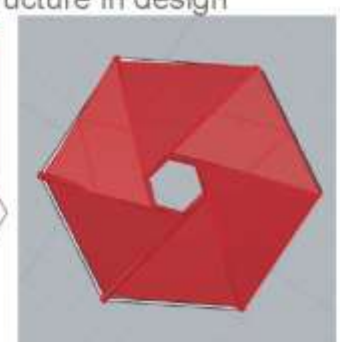
# Design Strategy

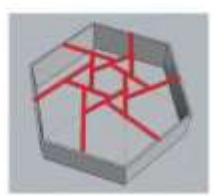


No central supports are required in the resulting RF-structures, and one can also disassemble and re-assemble these structures, facilitating their transportation from place to place.

This makes RF a highly cost-effective deployable system, particularly suitable for rapid constructions of temporary structures.

Utilizing material and structure in design



Local available material

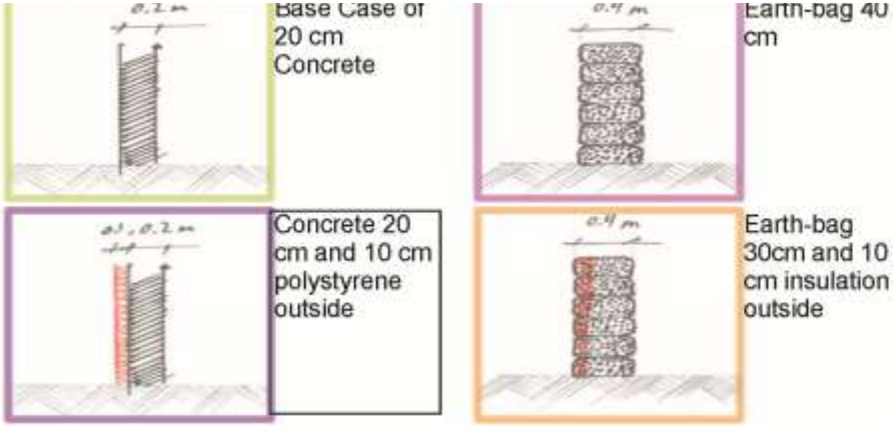
Investigation of vernacular techniques in adapting their shelters for extreme weather condition.

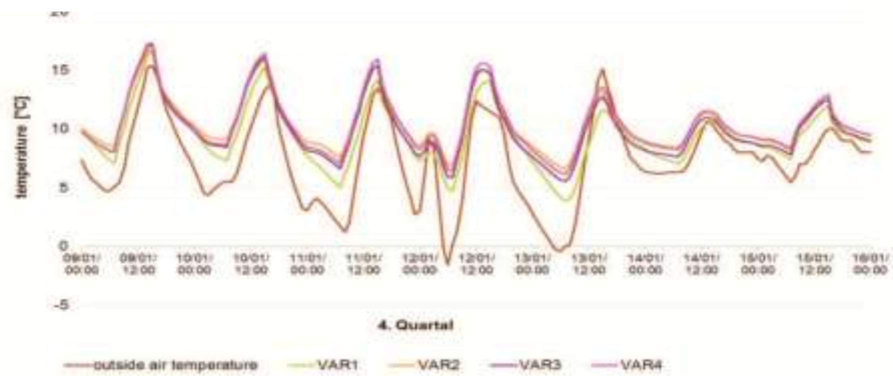
Utilization of earth from the site and stacking in earth bags to form an adobe walls to use as a base for the building envelope.

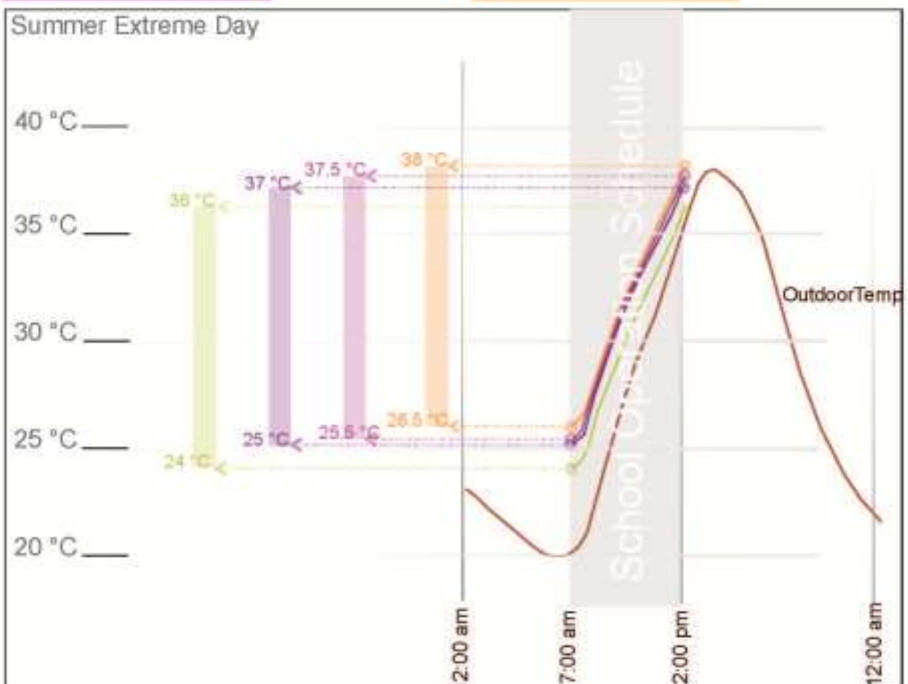
Traditional frame tent structure and envelope made of herds skin that have high insulation properties in extreme weather.

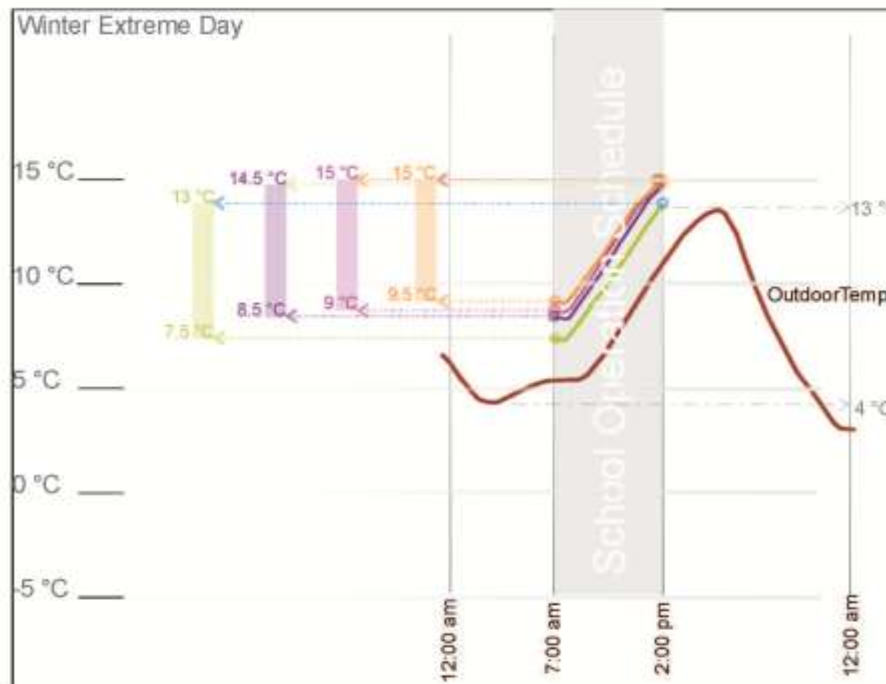
The design of roof vents for hearth and as a source of heat that would drive the ventilation mechanism inside the shelters

# Thermal Simulation

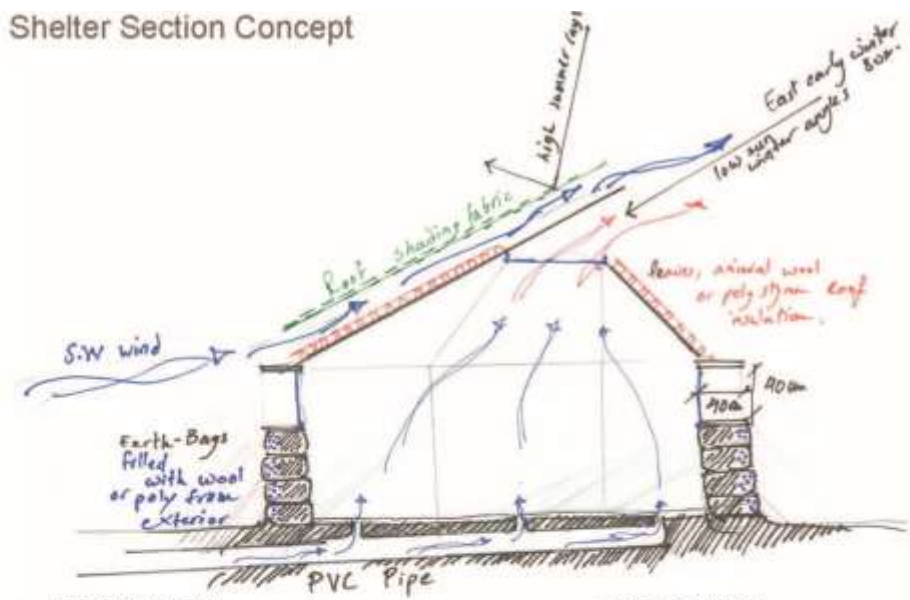


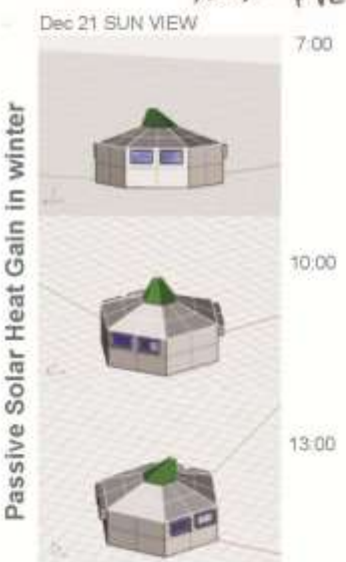



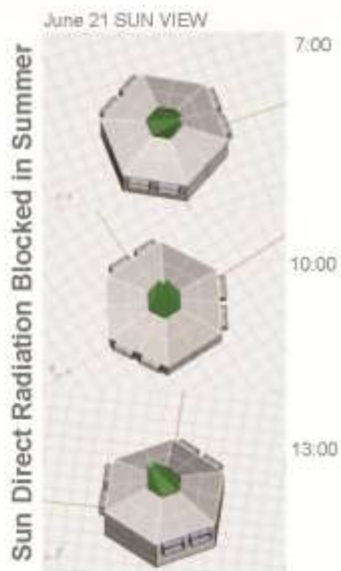



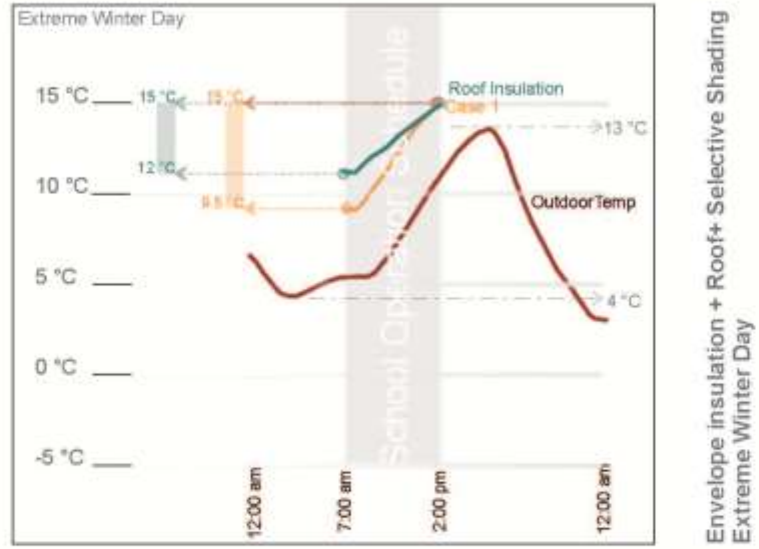



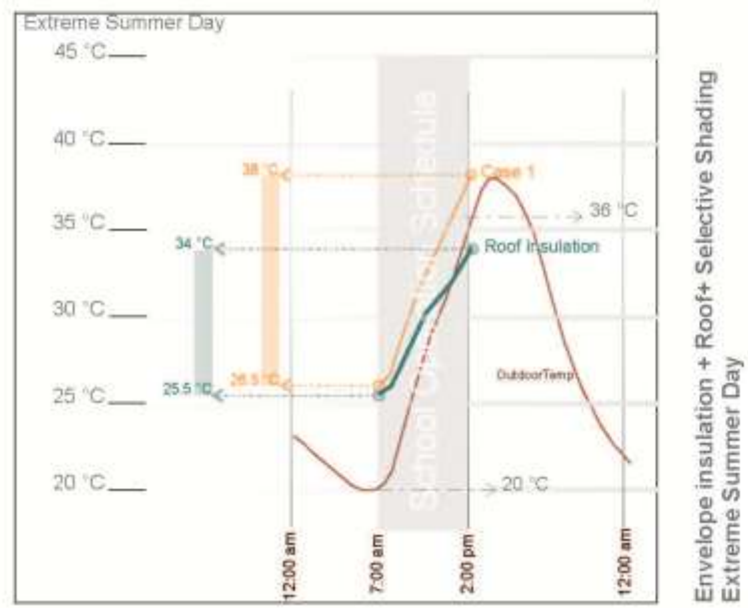
# Thermal Simulation



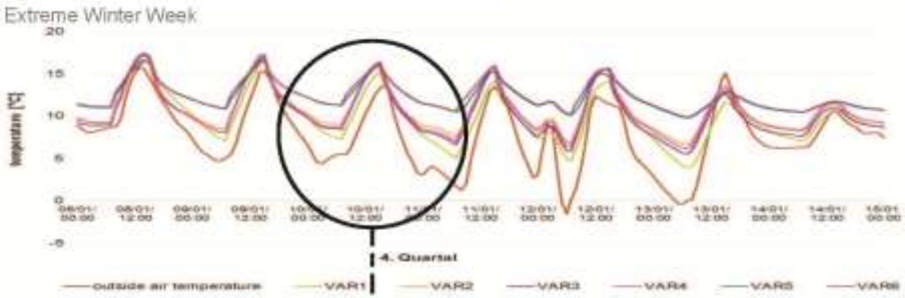



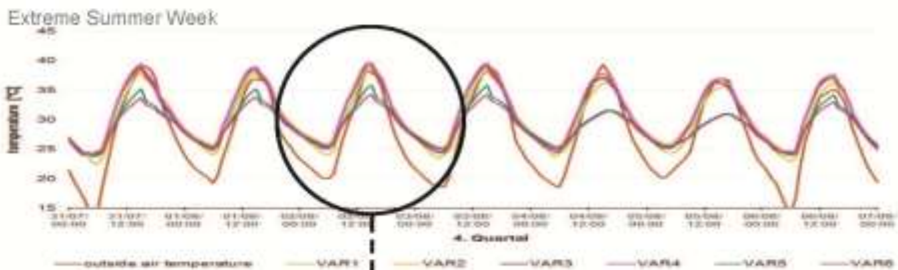



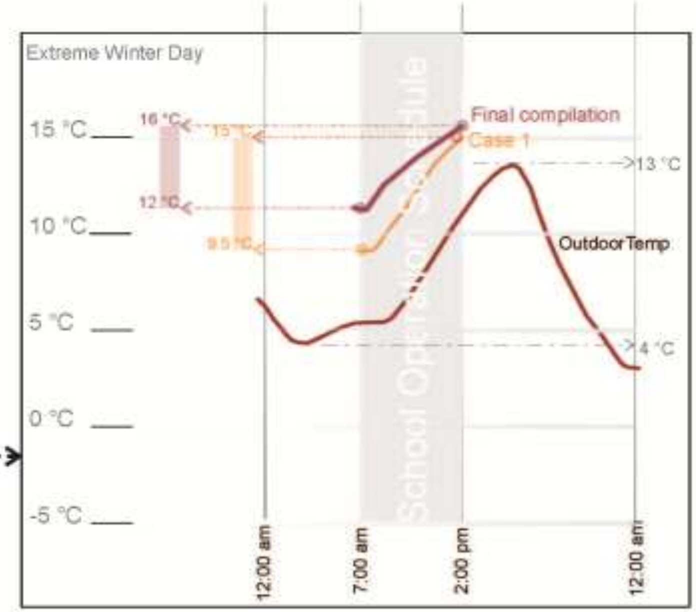



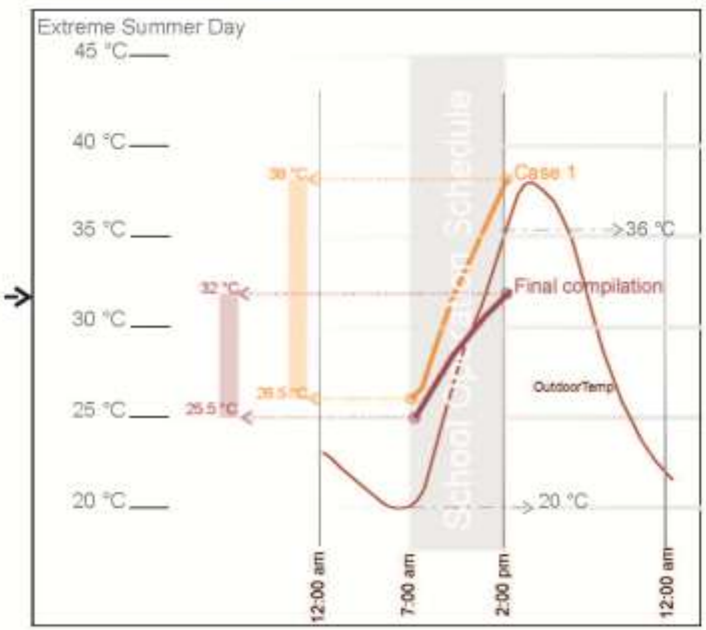
# Thermal Simulation




Envelope + Roof + Earth Duct
Winter Thermal Performance




Envelope + Roof + Earth Duct
Summer Thermal Performance

Enhanced Venteliation by roof nuzzle and for daylight enhancment

fabric on top for roof, shading in summer and prevent sky radiation exchange in winter

operable skylight and windows

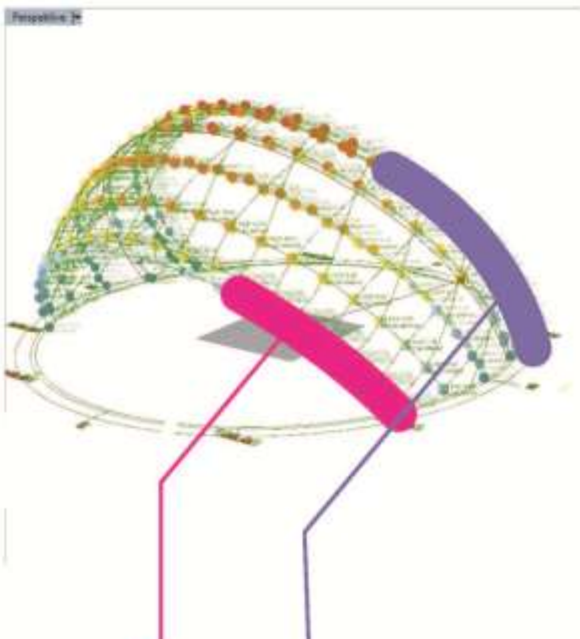
PVC Earth duct as main factor for ventilation

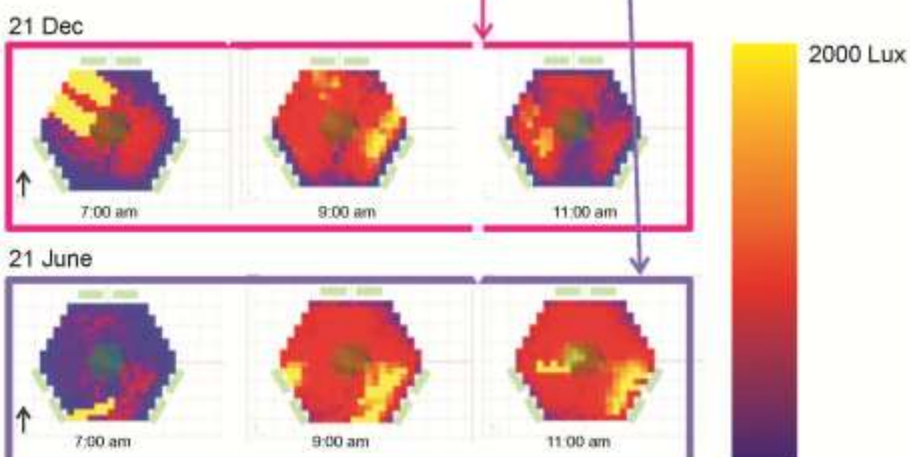
# Daylight Simulation

Morning illuminance Study inside the Class room space for 6 windows configuration

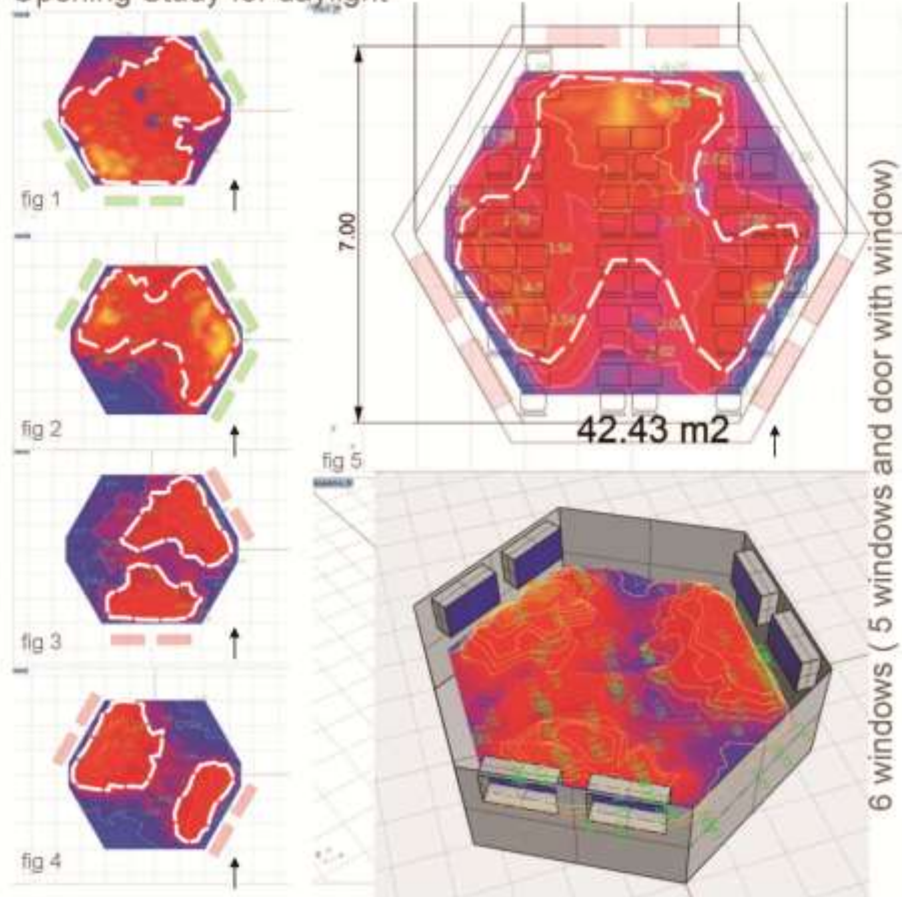
Direct Sun light is Blocked after 8:00

Summer early illuminance is minimized by skylight shading






Opening Study for daylight




Minimum of 6 windows distributed to get intended daylight levels for visual comfort in addition to the sky light with the shading element

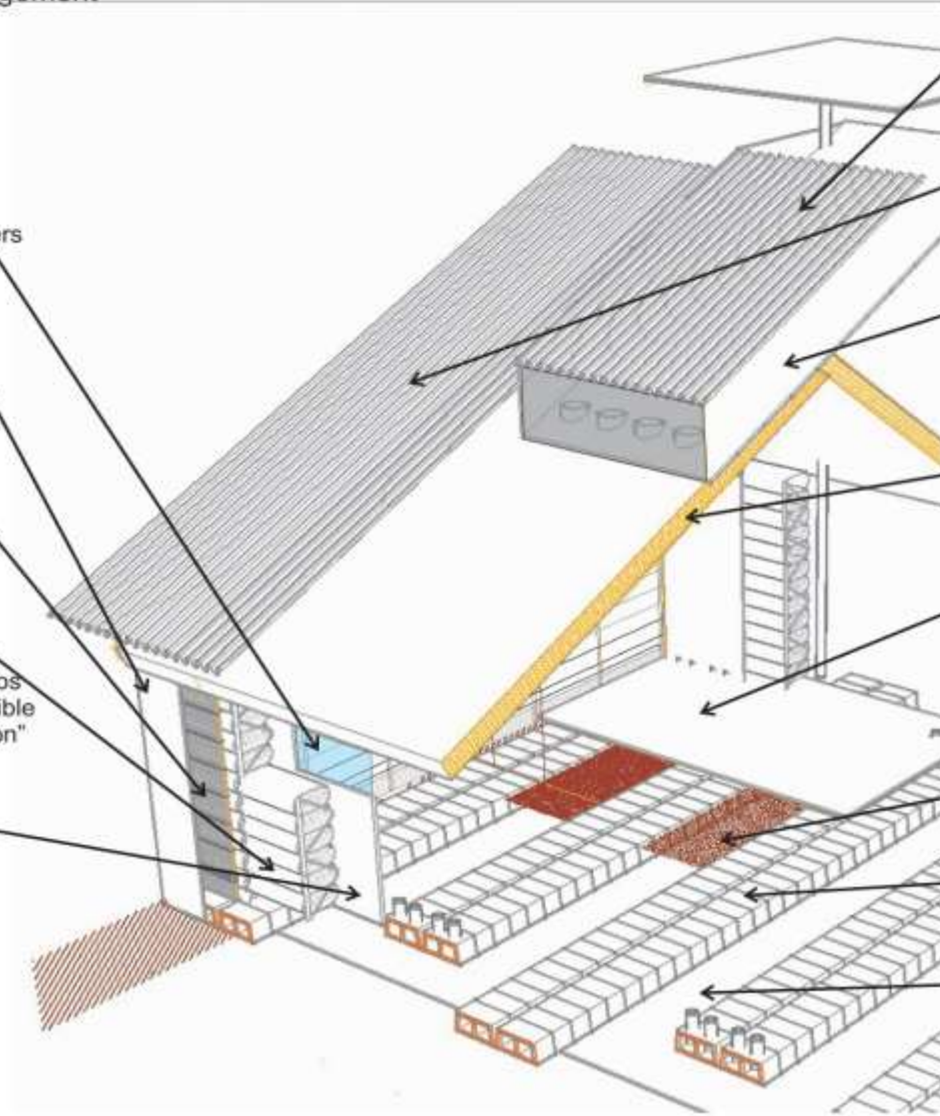
80 percent of area has daylight level above 3% at 1 m level

material reflectivity is set to 50% and white color

Earth bag best to be white for reflectivity and also window frames

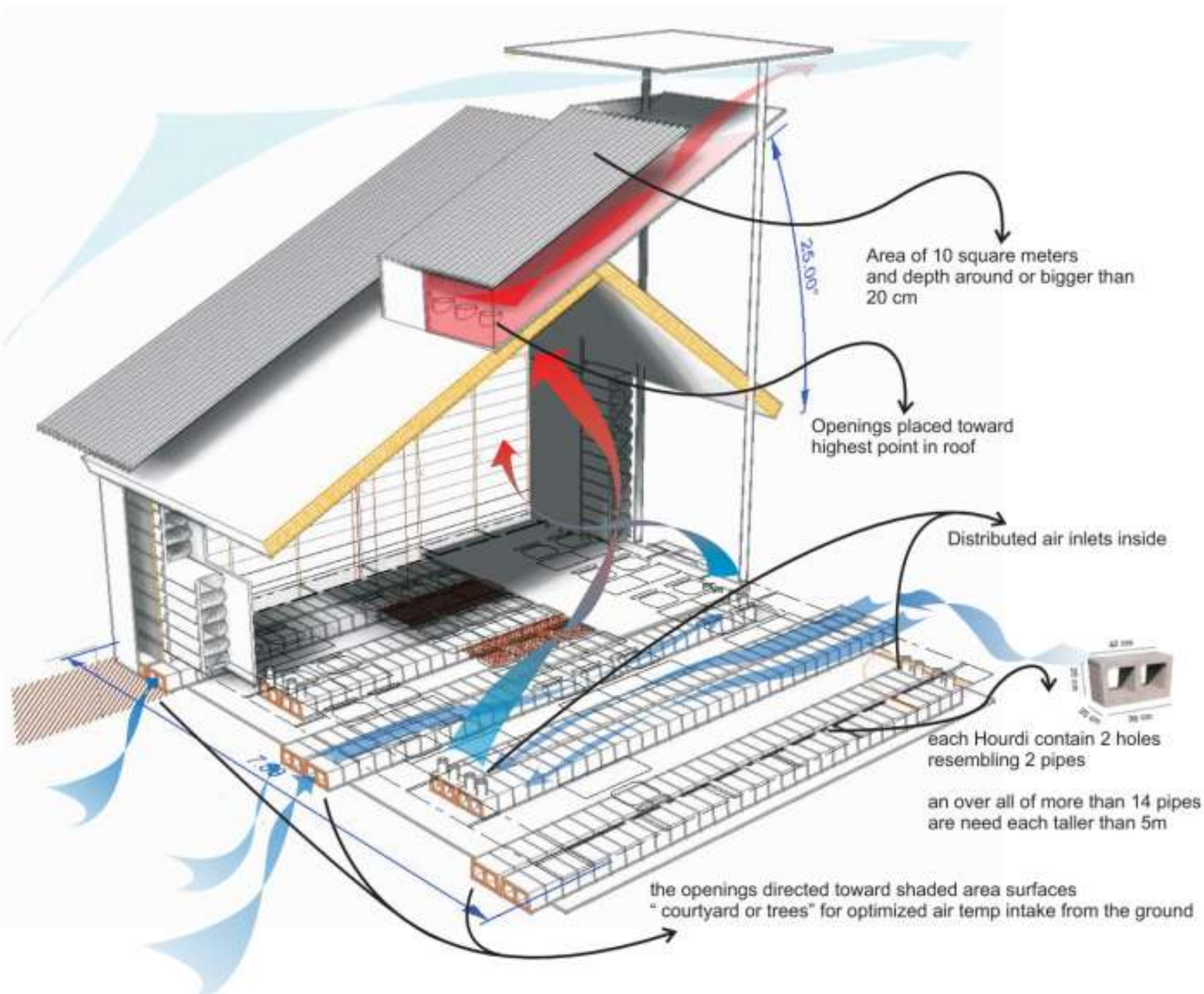
# Materials & Assemblage

## Material Description and Arrangement

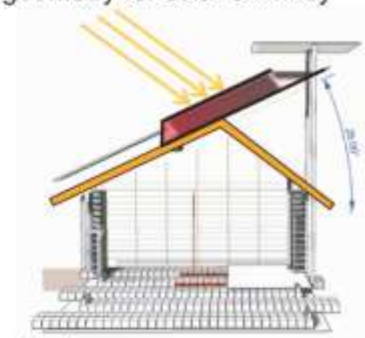


# Passive strategies

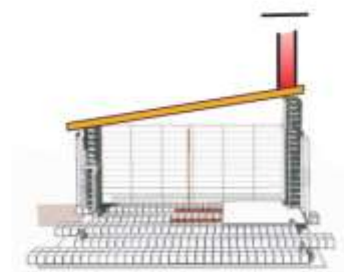
Guide Line for the solar chimney design
and the earth duct for the refugee school




Optional geometry for solar chimney



option 1



option 2

option 3

## Site Preparation/ Leveling

# Earth ducts assemblage

# Earth ducts assemblage

# Earth ducts assemblages

# Earth ducts outlets

# Sandbag fill soil testing

## Sand bag filling

# Footings assemblage

## Footings assemblage

# Waterproofing

# Eco-beam production for frame system

# Eco-beams assembling

# Eco-beams assembling

# Eco-beams assembling

# Frame system filling with sandbags

## Frame system filling with sandbags

# Plaster testing

# Plaster testing

# Insulation material preparation/ collection

# Installing roof insulation

# Installing roof insulation

## Roof structure assemblage

## Insulation material filling

# Insulation material filling

# Locals participation in implementation

# Locals participation in implementation

# Locals participation in implementation

# Thank you