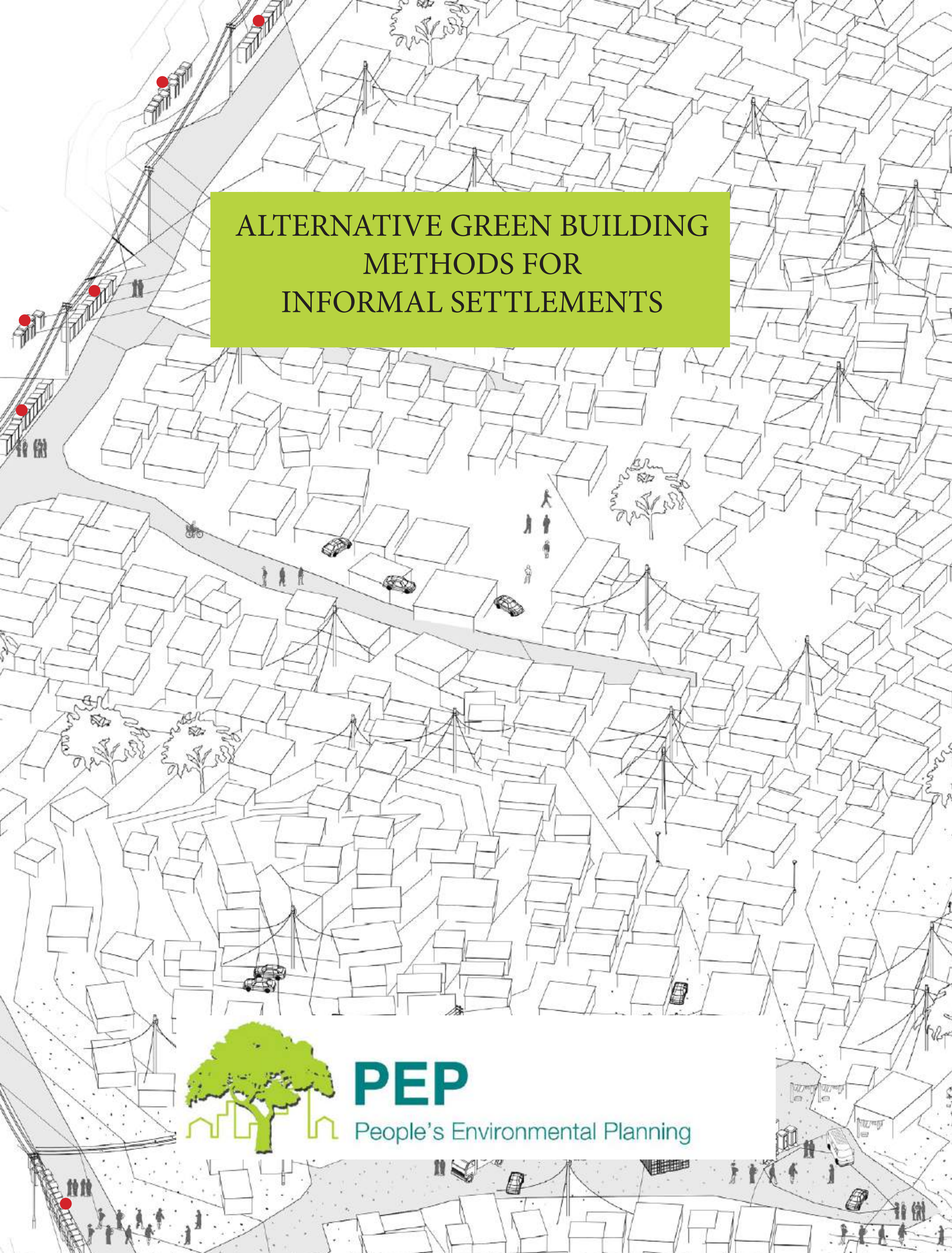
ALTERNATIVE GREEN BUILDING METHODS FOR INFORMAL SETTLEMENTS



PEP
People's Environmental Planning

Alternative Green Building Methods for Informal Settlements

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UCT KNOWLEDGE CO-OP

The UCT Knowledge Co-op facilitated this collaborative project between People's Environmental Planning and UCT (Architecture)

PEP
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EXECUTIVE SUMMARY

This document is designed to describe new and existing techniques that residents of informal settlements can implement as both individual and community-wide interventions to assist in their livelihoods for more sustainable living.

The following interventions provide a concise explanation of why residents would use these techniques. Each intervention is briefly described, providing details of how it works. This description is followed by illustrations that indicate the important aspects of the green build and attributes of each intervention. As this is purely a report based on general observations of several communities, not all techniques can be found in all informal settlements but are designed to be used elsewhere. The exact implementation and materials can vary between communities as well.

ACKNOWLEGEMENTS

I wish to thank the knowledge co-op for making the partnership between myself and Peoples Environmental Planning (PEP) possible. To Shawn Cuff, director of PEP, and Merhawi for their guidance and support during the research and compilation of this document.

TABLE OF CONTENTS


LETS BUILD
GREEN!

1 INTRODUCTION

This manual will allow people from all parts of Cape Town to contribute to the sustainable future of our city. Through the use of alternative green building practices, citizens will contribute to reducing the negative impacts of buildings on our environment, health and safety. 50% of our Greenhouse gas emissions are created by buildings, this is the leading reason of Climate Change. It is a responsibility of everyone on earth to contribute where possible through the use of green principles and resource efficient methods of building, otherwise the potentially catastrophic outcomes of climate change will be experienced.

1.1 WHAT IS GREEN BUILDING ?

Green building, or sustainable design, is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment over the entire life cycle of the building. Green building concepts extend beyond the walls of buildings and can include site planning, community and land use planning issues as well.

1.2 WHY DOES IT MATTER?

The growth and development of our communities has a large impact on our natural environment. The manufacturing, design, construction, and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources. Green building can not only improve the environment that we live in but also imrpove our socio-economic situations too.

Some of the green building methods many added benefits are listed here: > > >

ENVIRONMENTAL BENEFITS

- Enhance and protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste streams
- Conserve and restore natural resources
- Reduced resource consumption
- Improve indoor air quality
- Contribution to sustainable future for generations to come.

SOCIAL BENEFITS

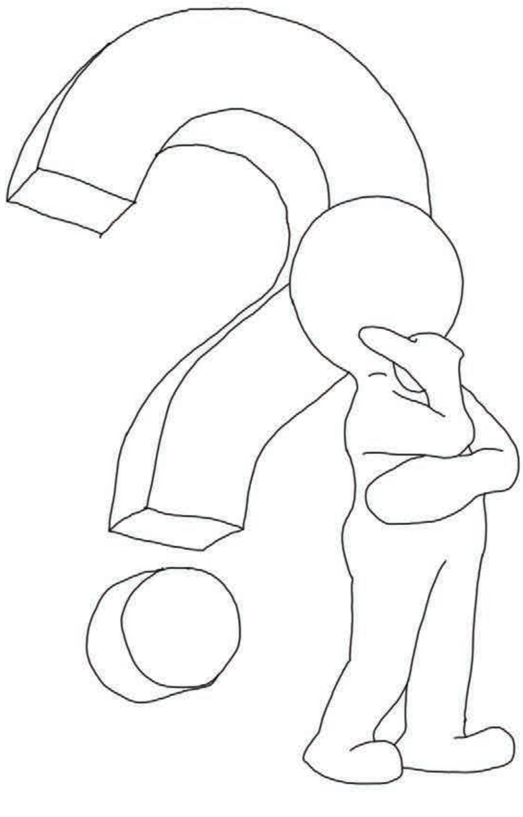
- Enhance occupant health and comfort
- Minimize strain on local utility infrastructure
- Improve overall quality of life
- Better well-being and therefore better lived experience
- Better human comfort levels
- Less health and safety risks

ECONOMIC BENEFITS

- Reduce operating costs
- Improve occupant productivity
- Enhance asset value and profits
- Optimize life-cycle economic performance
- Adding value to assets
- Lower household running costs
- Less utility costs

1.3 WHAT ARE THE COSTS?

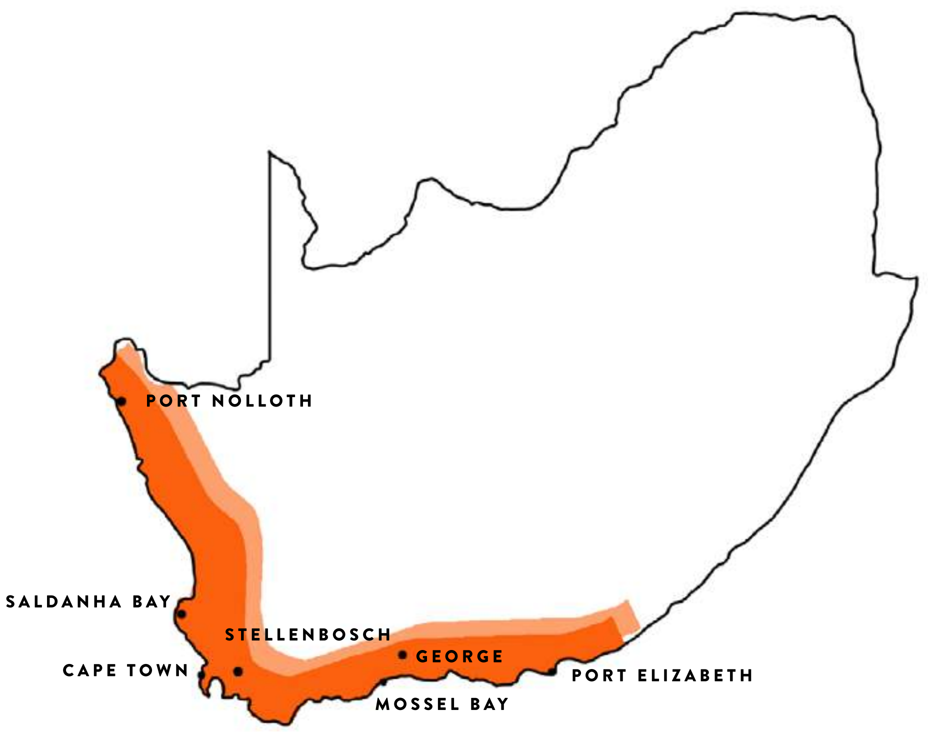
Building green is thought to be more expensive than conventional building methods. However this is not the case. By following green principles the various building features save on capital construction costs for example: by eliminating the need for electrical heating or cooling through the use of passive solar heating. Using materials and resources efficiently in the design process as well as upcycling waste and taking advantage of free energy and water all make sense to invest the money and effort in the beginning. Additional long term savings on operating costs and expenses in utilities. As increasingly becoming more recognised globally it makes sense to build green.



2 GREEN BUILDING | CAPE TOWN CONTEXT

2.1 TEMPERATE COASTAL | CLIMATIC

Cape Town is situated in the Temperate Coastal Climate region, the main climatic characteristics are low daytime temperature ranges near the coast and high daytime temperature changes inland. We have four distinctive seasons where the summer and winter conditions exceed human comfort ranges as opposed to spring and autumn where human comfort ranges are most perfect. Cape Town experiences mild/rainy winters with medium to high humidity. Summer brings hot temperatures with average humidity and strong winds.



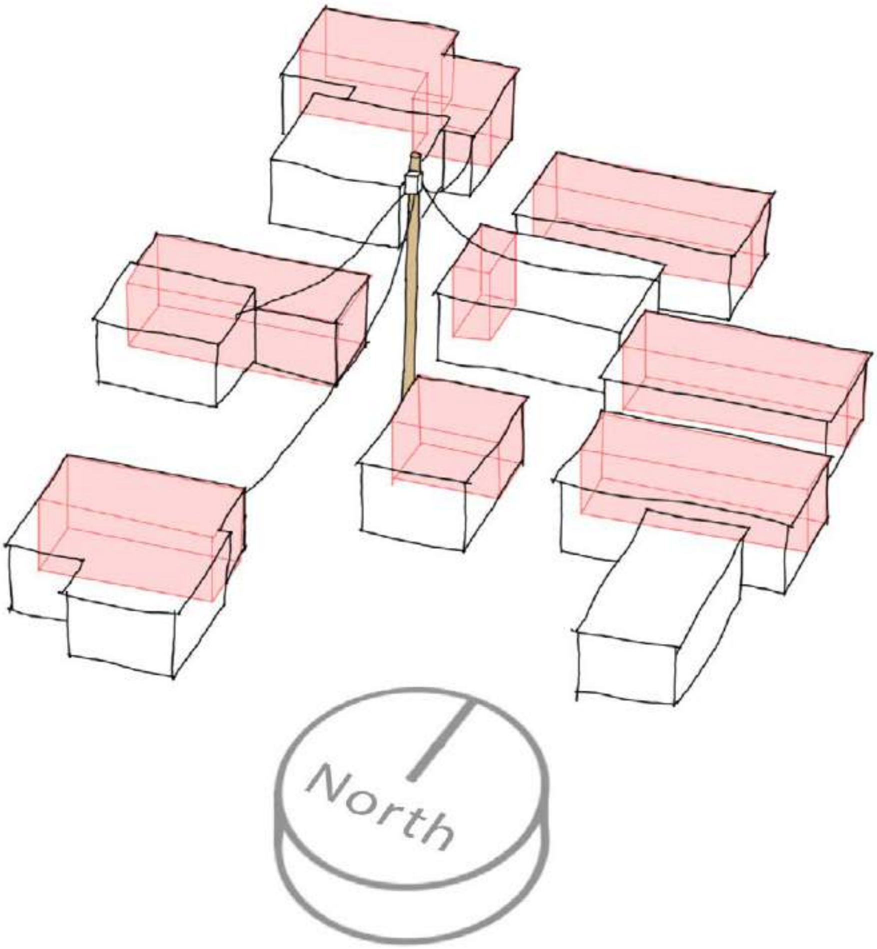
BEST DESIGN RESPONSES

- Use passive solar principles.
- High thermal mass solutions are recommended.
- Use high insulation levels, especially thermal mass.
- Maximise solar access in winter
- Minimise all east and west glazing, using adjustable shading.
- Minimise east and west walls.
- Use cross ventilation and passive cooling in summer.
- Use reflective insulation for summer heat.
- Use bulk insulation to ceilings, walls and exposed floor edges.
- Draught seal thoroughly, air lock spaces where possible.

2.2 SITE AND LAYOUT

Well thought out site planning and layout is crucial to taking advantage of sustainable building benefits. Through clever placement of the structure one can achieve a more inhabitable urban environment, use of natural drainage paths for flooding prevention as well as beautiful landscaping. The placement of the structure should try to retain or enhance the existing plant or tree life as there are many benefits to using them to contribute to the building's design. The building should make the most of the use of natural means of lighting, heating, cooling and ventilating. The orientation is also important for surveillance and security, and the prevention of fires.

- Lower household running costs
- Reduced resource consumption
- Better well-being and therefore better lived Experience
- Better human comfort levels
- Less health and safety risks
- Less utility costs
- Adding value to assets
- Adding longevity to assets
- Contribution to sustainable future for generations to come.



Daytime living areas shaded in red, north facing living spaces are preferable

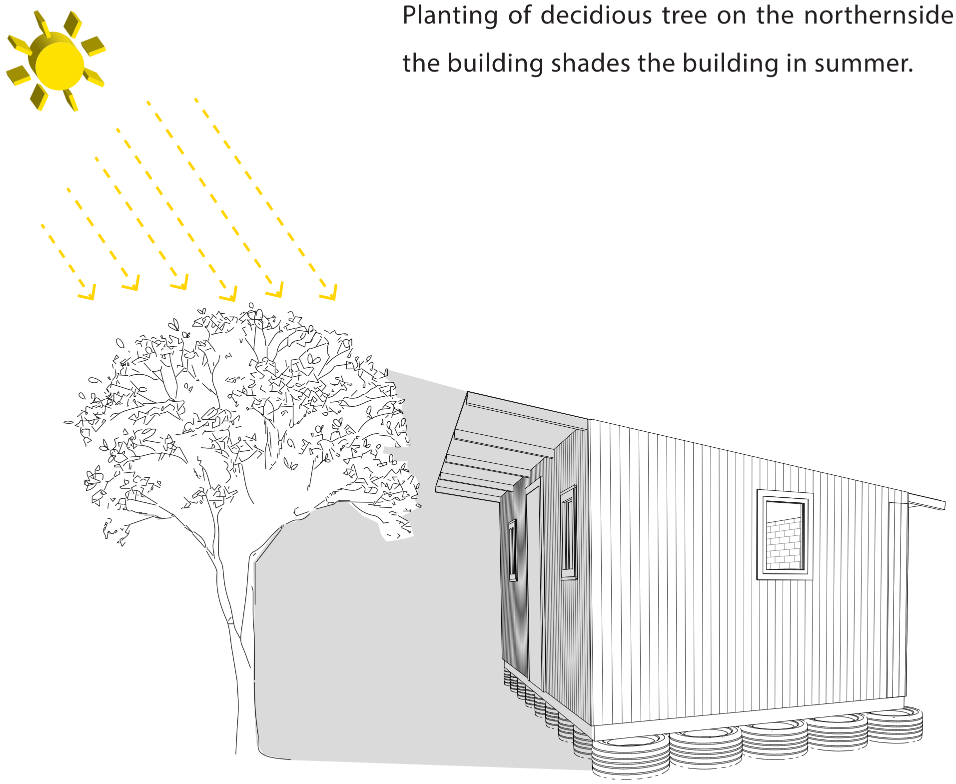
2.3 SOLAR HEATING

Passive solar heating principles harness the heat from the sun together with the buildings shape, orientation, natural convection, use of materials and buildings design elements to heat and cool the building naturally. The combination of an insulated building envelope with simple design decisions to prevent heat loss. Once sunlight enters the building the heat can either be absorbed, reflected or transmitted to achieve various outcomes, namely eliminating heating and cooling operating costs and creating ideal living environments. In Cape Town, homes are subjected to overheating due to high summer temperatures, thus when building, one needs to consider cooling the building in summer while still keeping it relatively warm in winter without the unnecessary use of costly air-conditioning.The ideal shape of the building should be elongated in an east-west direction with large north facing openings. This ensures the northern side of the building receiving the most amount of sunlight in winter months, more importantly catching the morning to early afternoon sun.

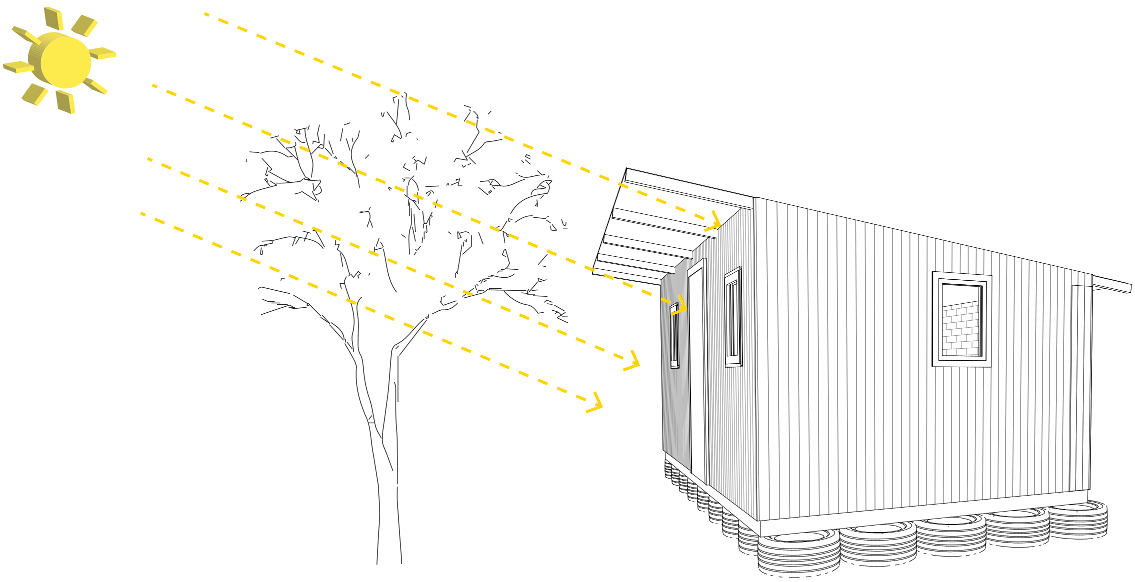
This allows the building to be warmed, lit and ventilated simultaneously to achieve ideal comfort. In order to avoid overheating, the openings should be extended to prevent direct solar radiation in summer and allow in the low winter solar radiation. In addition, external shutters can be used to adjust solar heating and lighting, internal shading will not prevent heat gain. Another well used shading device is that of a deciduous tree which shades in summer and loses its leaves in winter, a great use of nature to regulate temperatures. The understanding of prevailing winds should also be taken into account as to allow in the soft breezes and avoid the strong winds from entering the building.

- Orientation
- Building shape
- Space planning
- Natural/built shading
- Few openings on South/West walls
- Many or large openings on North/ East
- Good insulation
- Thermal mass

Planting of decidious tree on the northernside of the building shades the building in summer.



Decidious tree loses its leaves in winter allowing winter sun to warm the building.



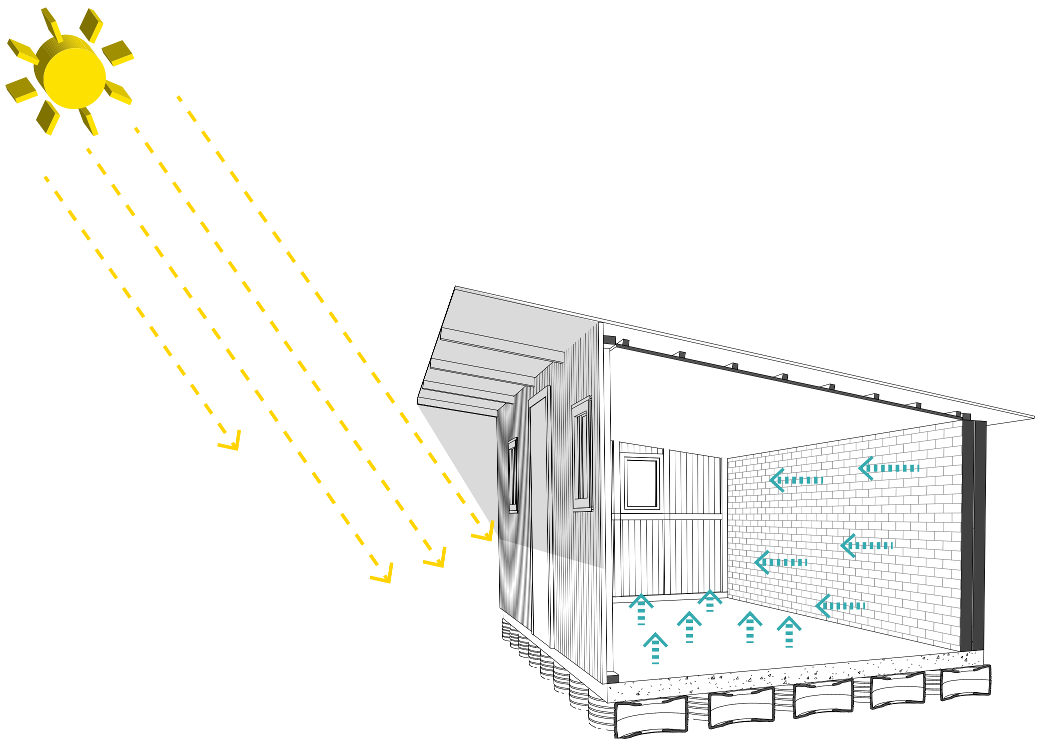
THERMAL MASS PRINCIPLES

2.4 THERMAL HEATING

Thermal mass principles are based on the ability of materials to store heat, retain it and release the heat later. This is particularly important in reducing fluctuations in heat, making the average internal temperatures moderate all year round. Heavy weight materials such as brick and concrete have more thermal mass than lightweight timber construction. By using brick walls and concrete slabs where possible, the buildings temperature will be cooler than a lightweight building. Therefore by using materials with thermal mass the building will need less heating and cooling requirements. A rule of thumb ratio for thermal mass is 1:6, this ratio explains that the area of exposed thermal mass in a room should be six times greater than the area of glass that has solar access. If the room is $6m_2$ there should be a window of $1m_2$

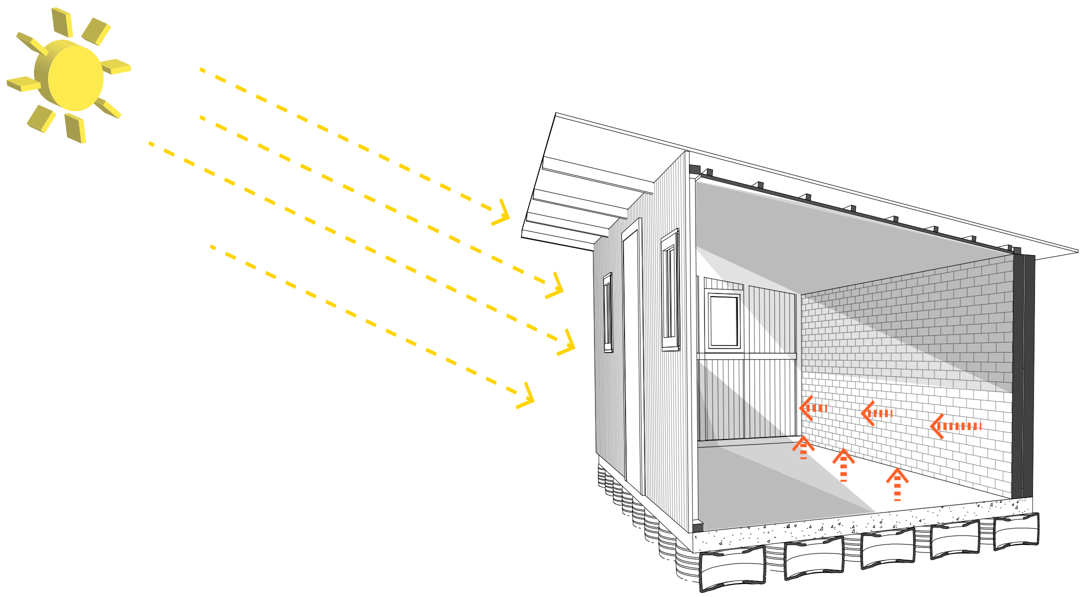
- Thermal mass in walls
- Thermal mass in floors
- Additional heating applications against South thermal mass wall

High summer sun



Thermal mass keeps
the building cool in summer.

Low winter sun



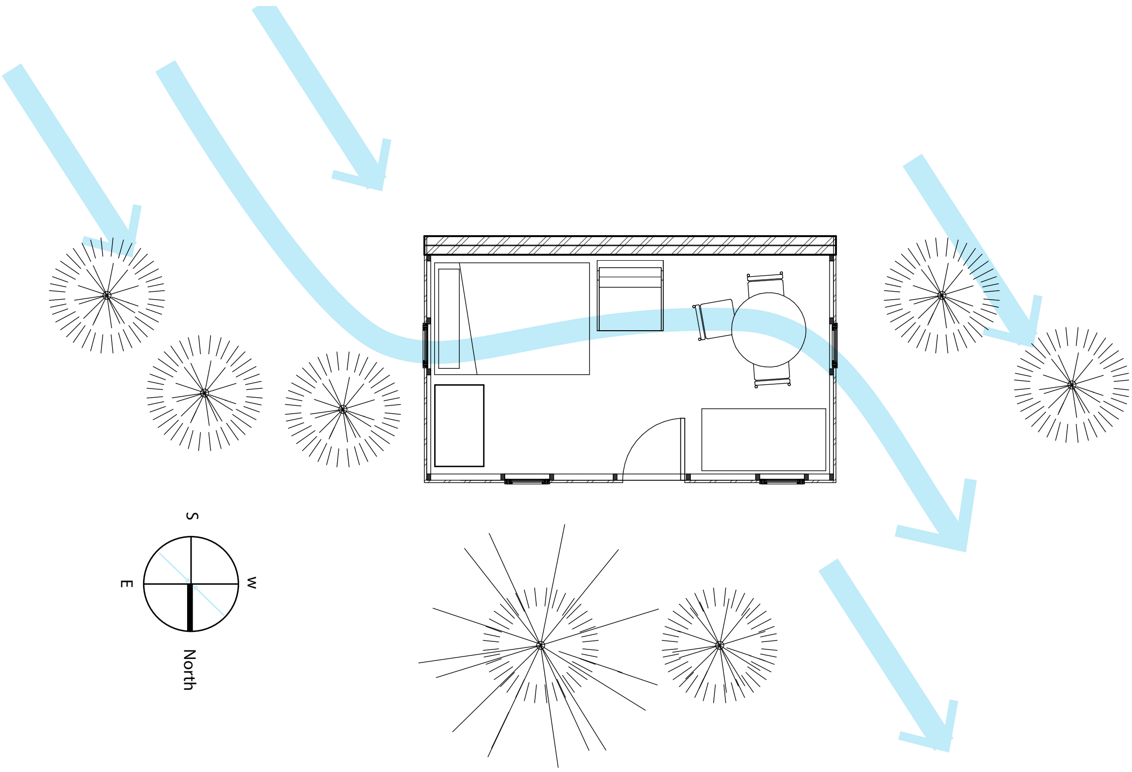
Thermal mass keeps
the building warm in winter.

PASSIVE VENTILATION PRINCIPLES

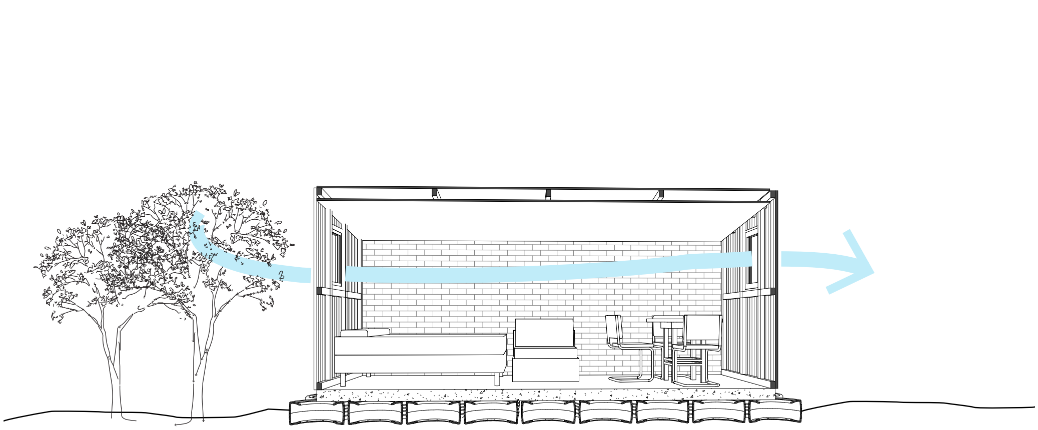
2.5 CROSS VENTILATION

Passive ventilation principles harness air movements from outside and inside the building and use them to draw in cooler, fresher air in order to reach desired comfort levels. By either using the prevailing wind cleverly, or using the heating of air to create difference in air pressure to exhaust warm air out of the building, a person can quickly adjust the temperatures within a building. Ventilation rates are reliant on good design decisions where there is minimal disturbances in its movement as well as the buildings orientation, shape and interior layout. The four types of ventilation looked at are single sided ventilation, cross ventilation, the stack effect and wind catchers.

Plan view of the planted trees diverting the prevailing wind through the interior of the building.

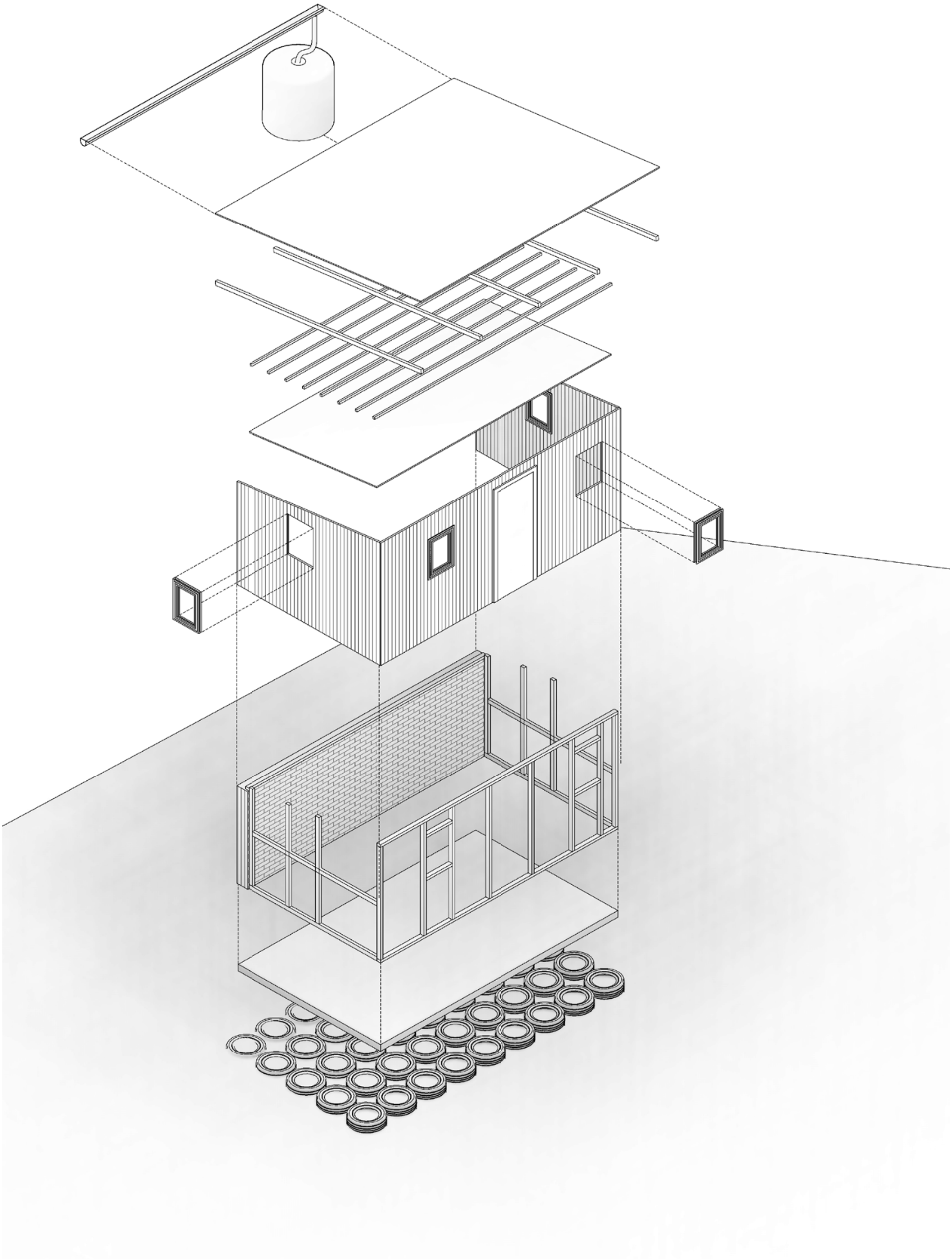


Sectional view showing cross ventilation



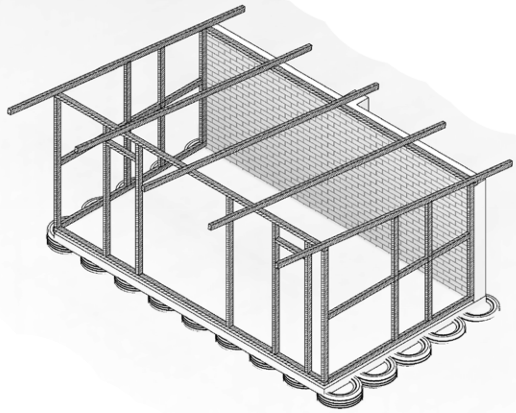
3 GREEN CONSTRUCTION METHODS

This section of the manual shows various alternative construction techniques to make the 'greening' of the house more accessible people on a budget. By replacing expensive materials which consume large amounts of energy to manufacture with natural or recycled materials and the use of simple construction strategies one can achieve the same efficiencies as a construction with a large budget.



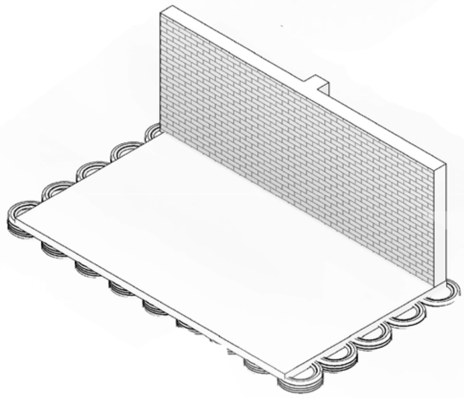
STEP 4

Timber frame as support for enclosure



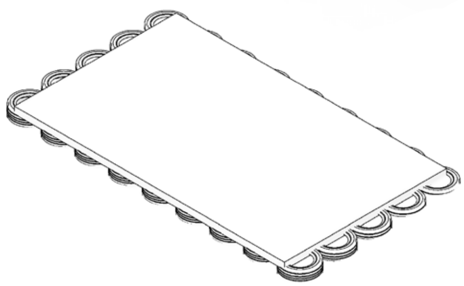
STEP 3

Masonry wall for thermal mass and begining start of formalised building process



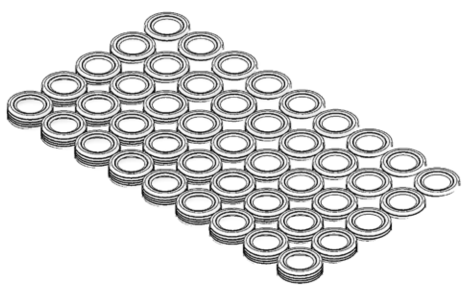
STEP 2

Cast foundation as base for built structure.

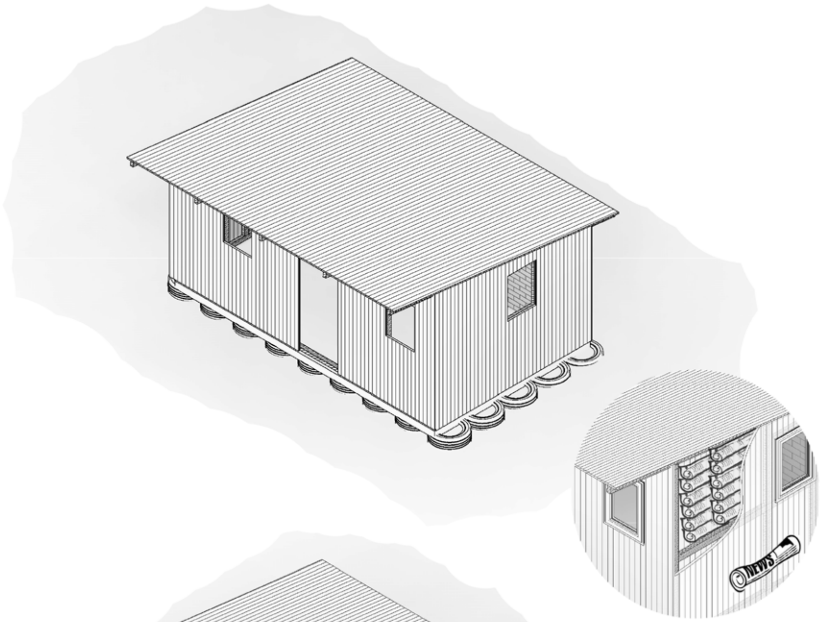


STEP 1

Tyres as base for foundation and height above ground.

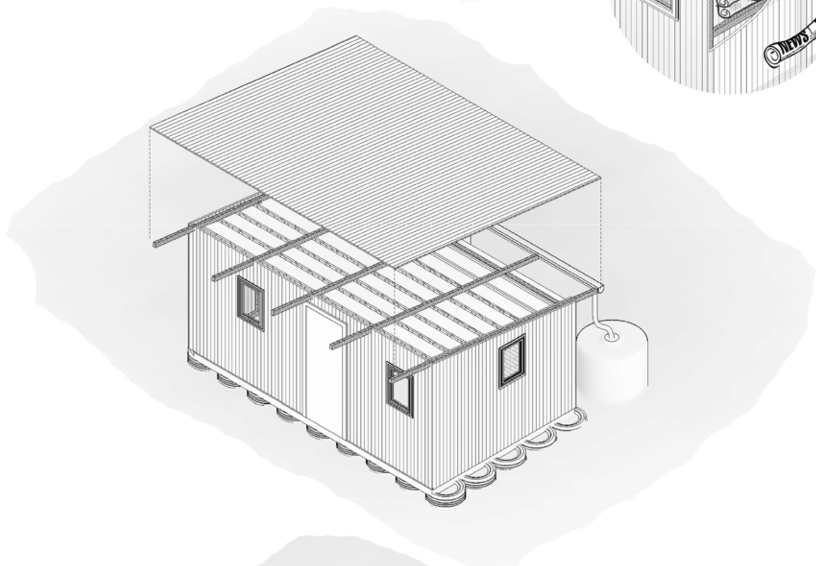


STEP 5



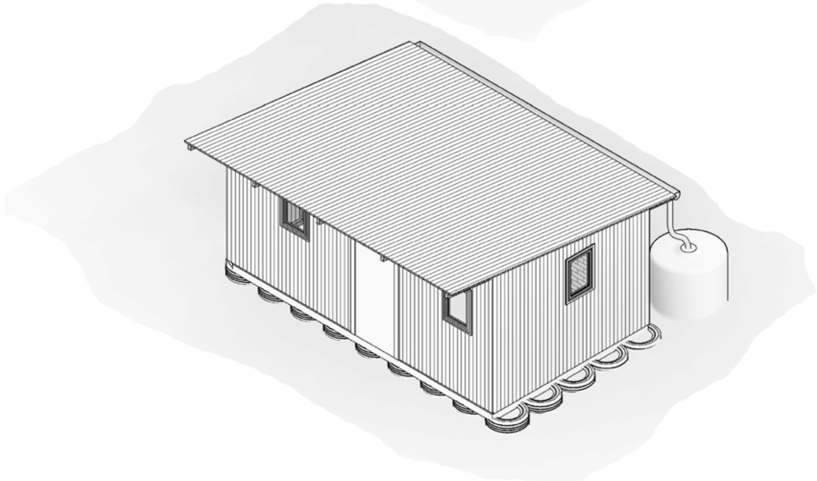
IRB sheeting as building skin with tightly rolled newspaper for insulation.

STEP 6



Insulated ceiling to keep building cool in summer and warm in winter, and windows and doors for ventilation and lighting

STEP 7



Gutter and rain water harvesting tank for household water usage

3.1 MIXING CONCRETE

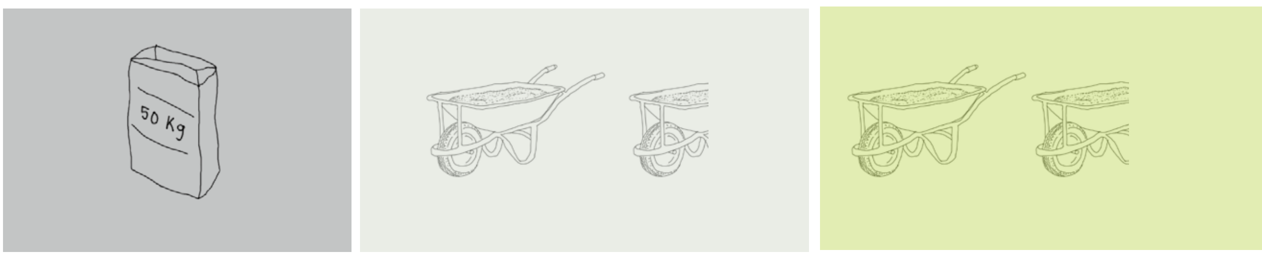
When mixing concrete people need to understand the different steps and materials in order to achieve the quality and strength needed for the job. When cement and water are mixed a chemical reaction known as hydration takes place. This turns the liquid mixture into a solid one. In order to achieve different strengths other materials known as aggregates are added, such as sand and stone. These materials together create concrete. The ratio between the water and cement determines the strength – the more cement in the mix the harder/stronger the concrete will be. For additional strength, steel reinforcing is added.

30Mpa Concrete: High strength, suitable for reinforced concrete members and heavy duty floors

Cement River Sand Stone

25Mpa Concrete: Medium strength, suitable for reinforced and unreinforced slabs, foundations and paths

Cement River Sand Stone



15Mpa Concrete: Low strength, suitable for single storey unreinforced foundations,

Cement River Sand Stone

STEP 1

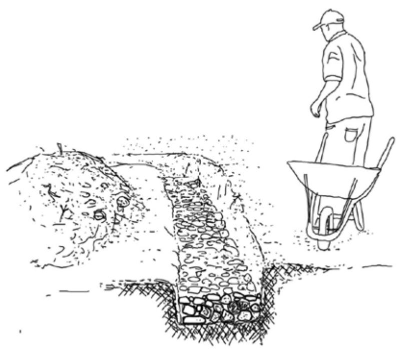
Batching by volume, measuring the materials by load in a wheelbarrow

STEP 2

Incrementally add water and mix thoroghly

STEP 3

Fill formwork with concrete mixture



3.2. DRAINAGE: FRENCH DRAIN

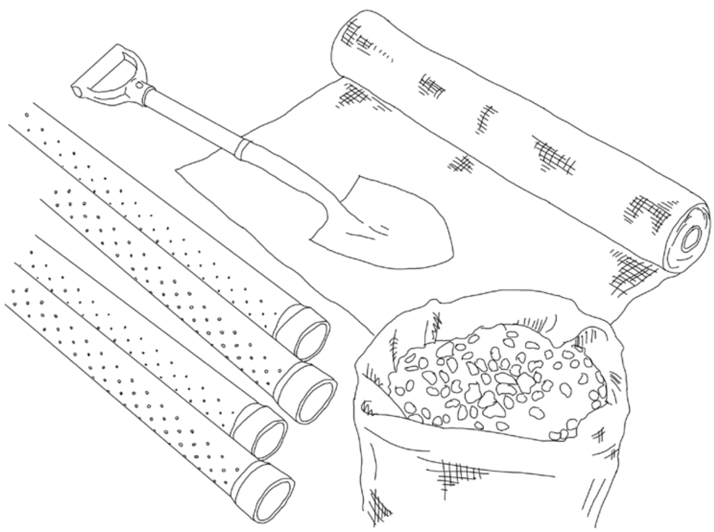
A French drain is a trench filled with gravel or rock, containing a perforated pipe that redirects surface water and groundwater away from an area in order to prevent flooding. A French drain can have perforated hollow pipes along the bottom to quickly vent water that seeps down through the upper gravel or rock.

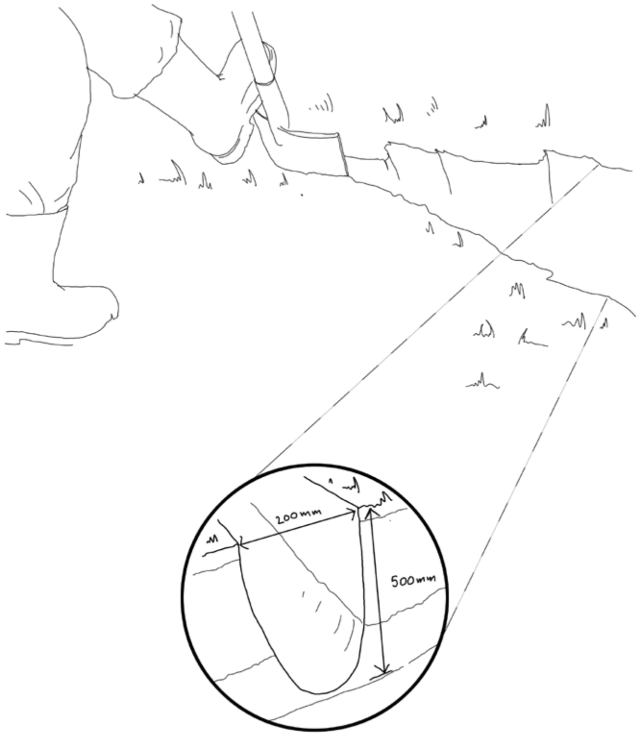
French drains are primarily used to prevent ground and surface water from penetrating or damaging building foundations. Alternatively, French drains may be used to distribute water, such as a septic drain field at the outlet of a typical septic tank sewage treatment system. French drains are also used behind retaining walls to relieve ground water pressure.

STEP 1

What do you need?

- A perforated plastic drain
- Permeable landscaping cloth
- Washed drainage gravel
- Tools for digging





STEP **2**

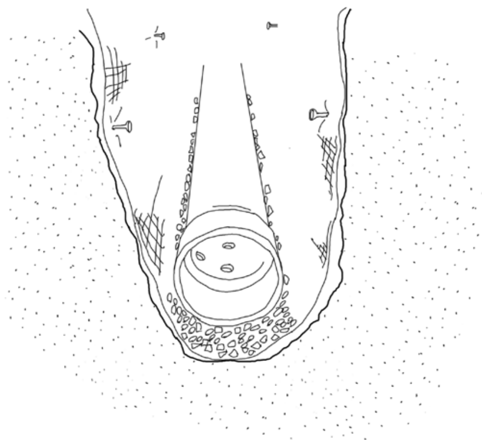
Dig a trench approxamately 500mm deep by 200 -300mm wide

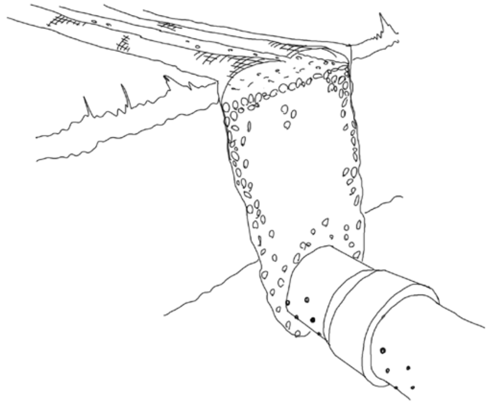
STEP **3**

Line the trench with the permeable landscaping cloth, add a thin layer of washed gravel then lay the pipe

STEP **4**

Fill the remainder of the trench with the washed gravel, leaving a small amount of landscaping cloths edges exposed.

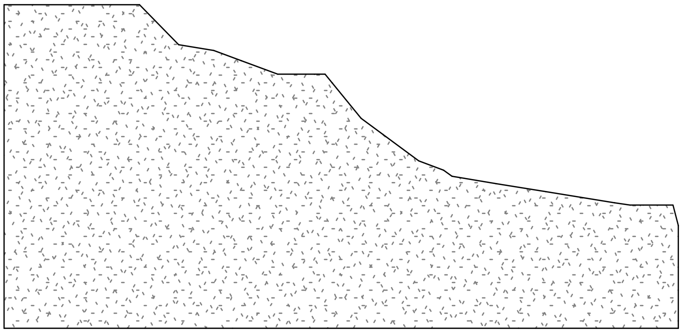




3.3. EARTH RETENTION USING TYRES

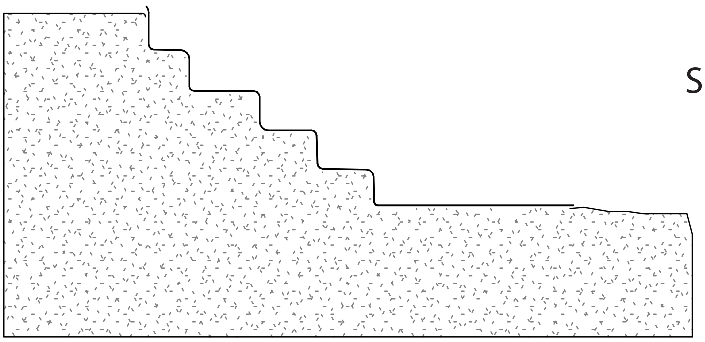
Old vehicle tyres are used in various ways to help prevent household flooding. When incorporated with sand - that is usually accessible along the general surroundings - they can be useful in producing a stable surface that is able to withstand the pressures of water runoff. Tyres are used to stabilize the sand and prevent it from moving and shifting during a rain storm. They can also be used to form a barrier against water by being stacked on top of one another, ultimately forming a wall-like structure that is similar to a fence.

The design involves burying the tyres into the sand or stacking the tyres on top of one another and then filling them with sand. Burying the tires into the sand stabilizes the sand and help to reinforce the ground by providing enough extra support to keep the sand from moving around and creating unwanted natural paths and channels that redirects water into houses and shacks. Without the sand in the tyres, they would not be strong enough to redirect the water, as the flow would be too powerful and would begin to move the tyres and knock them over. To further stabilize the tyre wall, plant vegetation in order to utilise their root systems as natural earth anchors and provide an extra food resource.



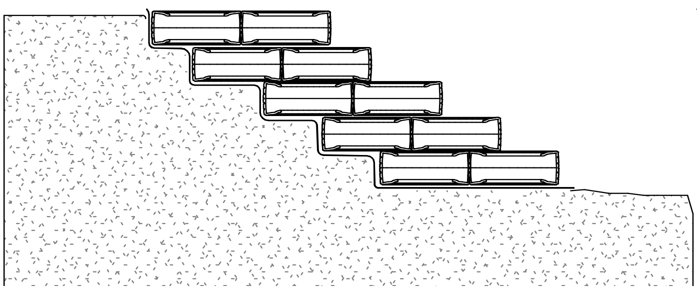
STEP 1

Locate problematic slope



STEP 2

dig 'steps' out of slope and lay landscaping cloth along steps.

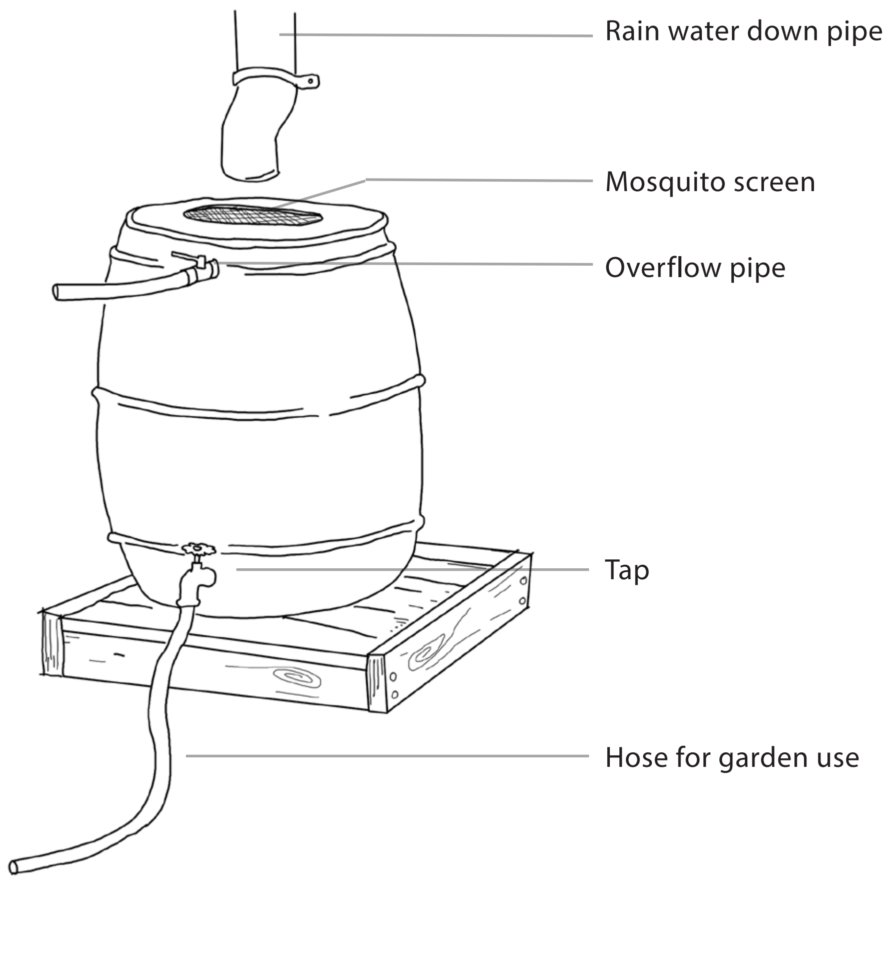


STEP 3

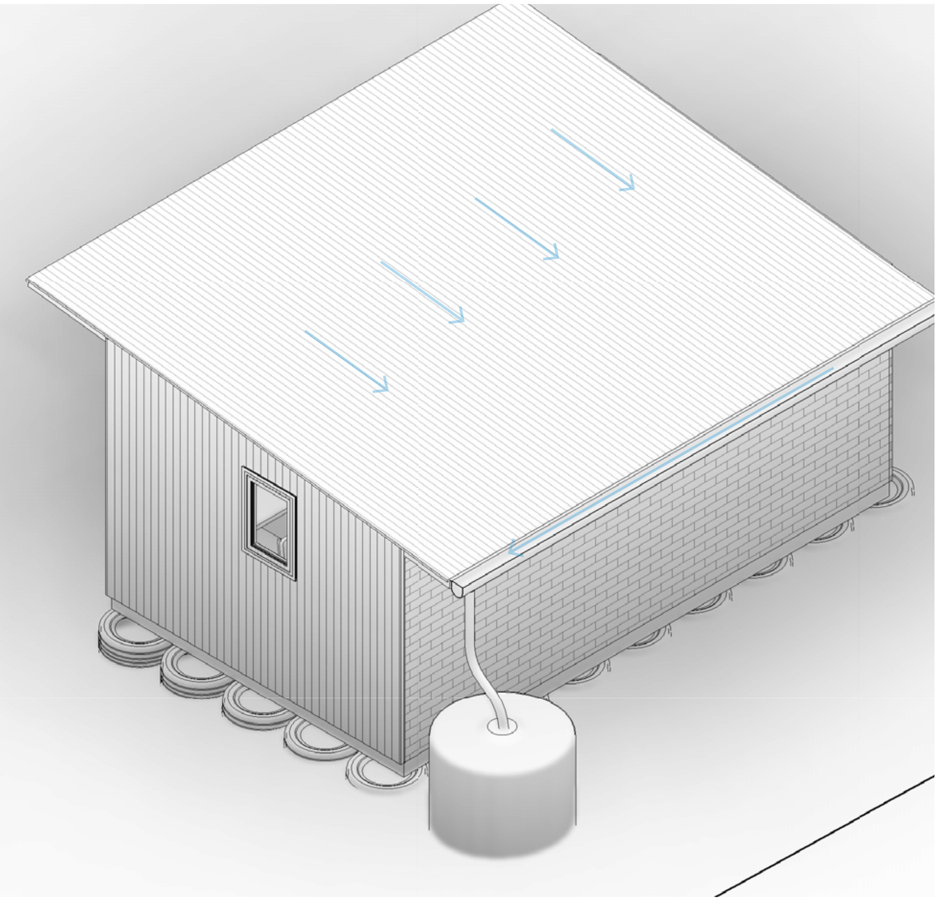
Lay first layer of tyers and compact with earth, then lay second layer of tyres, fill with soil and plant with vegetation of choice.

3.4. RAINWATER HARVESTING

Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques such as underground check dams. Rooftop catchments: In the most basic form of this technology, rainwater is collected in simple vessels at the edge of the roof. Variations on this basic approach include collection of rainwater in gutters which drain to the collection vessel through down-pipes constructed for this purpose, and/or the diversion of rainwater from the gutters to containers for settling particulates before being conveyed to the storage container for the domestic use. As the rooftop is the main catchment area, the amount and quality of rainwater collected depends on the area and type of roofing material.



Reasonably pure rainwater can be collected from roofs constructed with galvanized corrugated iron, aluminum or asbestos cement sheets, tiles and slates, although thatched roofs tied with bamboo gutters and laid in proper slopes can produce almost the same amount of runoff less expensively (Gould, 1992). However, the bamboo roofs are least suitable because of possible health hazards. Similarly, roofs with metallic paint or other coatings are not recommended as they may impart tastes or colour to the collected water. Roof catchments should also be cleaned regularly to remove dust, leaves and bird droppings so as to maintain the quality of the product water



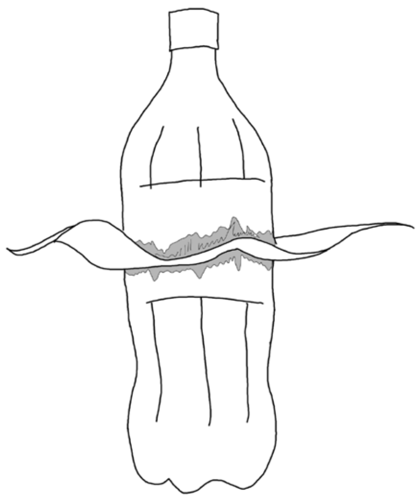
3.5. LIGHT IN A BOTTLE

The simplified construction uses a plastic soda bottle with water inside and a little bleach (to keep algae from growing) poked through a tin roof with a third of the bottle sticking above the roof, which allows the sunlight to enter and the light to refract into the room. Naturally, the hole in the roof must be sealed with glue or caulking so the rain doesn't get in.

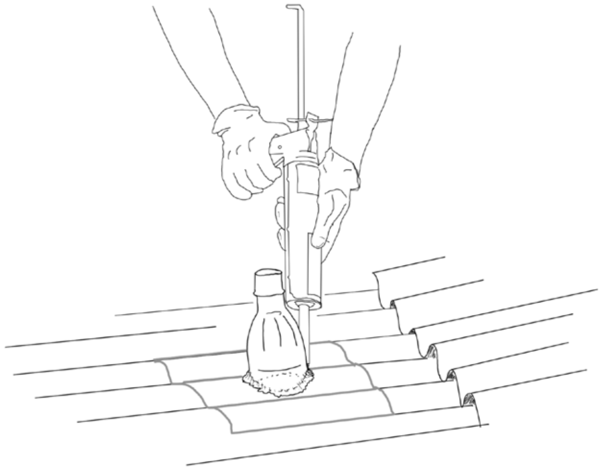
Finding a recycled use for plastic soda bottles is a tremendous benefit of its own. With ever-expanding globalization, the proliferation of plastic garbage poses both ecological and human health threats. In remote regions, goods come in but garbage doesn't go out. It is left behind and the responsibility for disposal rests with people who already have too little and on communities without services.

STEP 1

Cut a piece of corrugated iron approximately 30cm x 30cm and cut a hole in the middle ot the sheet the same size of the plastic soda bottle. Insert the soda bottle and apply a rubber sealant or epoxy resin in order to make it water tight.



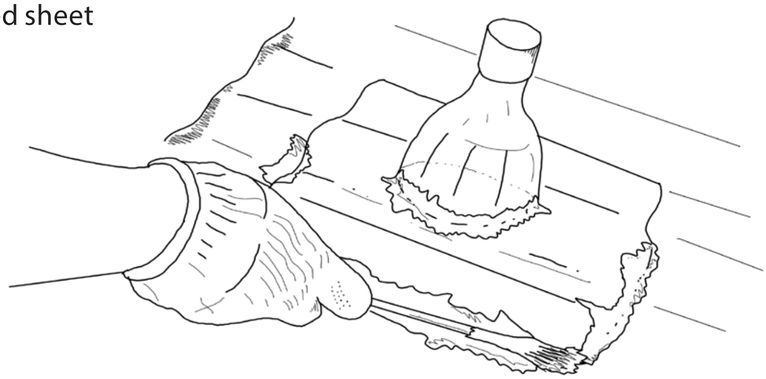
STEP 2



Cut a hole the same size of the soda bottle and glue the bottle and its corrugated sheet directly to the roof, ensure glue or sealant is spread equally in order to make it watertight.

STEP 3

Fill the bottle up with water, if possible add a table spoon of chlorine. Add an additional layer of sealant around the corugated sheet as well as the soda bottle.



3.6. PLASTIC BOTTLE WALL

People have been building with bricks, tiles, concrete and rocks along with various other construction materials for generations, however the recycling of plastic bottles can be utilised as an alternative to masonry units. Using plastic bottles can dramatically reduce costs without compromising the strength of the wall. This method is an innovation which contributes to low cost housing and without negatively impacting the environment.

The bottle walls would be typically made on a foundation with rebar set into a foundation to secure the wall and add to its structural integrity. The bottles should all be of similar size, filled with compacted soil or sand. The bottles are then tied to each other from the first to the last bottle. Stacked neatly next to each other and spread with a thick layer of cement/mortar to bind the bottles together. It is similar to masonry construction but with the use of a readily available waste material.

- A small house would use as many as 15000 bottles, waste that would otherwise be taken to a landfill or burnt.

- Traditional bricks are burnt in a process which uses large amounts of fossil fuels and contributes to deforestation, thus by using bottles you are protecting the environment.

- The buying of bottles from vendors essentially funds a grassroots recycling campaigns, in the absence of a government initiated waste management systems.

- Plastic bottles take around 300 years to decompose, which makes them a reliable long lasting building material.

- The material compacted in the bottle provides thermal mass by absorbing solar radiation during the day and releasing the radiation at night.

STEP 1

Fill bottles with sand and compact as you go.

STEP 2

Tie bottles to each other in rows and bind each row with a thick layer of mortar.

STEP 3

Tie bottle necks to eachother, this is for additional stability and makes the application of plaster easier.

3.7. RAT-TRAP BOND WALL

This method of masonry wall construction uses conventional bricks placed in a vertical position instead of the conventional horizontal position. This method creates a cavity within the wall which can be used as a loadbearing wall or a thick partition wall. The rattrap bond is used widely in India for its reduced construction cost relative to the conventional masonry walls, using less bricks and less mortar and achieving better thermal capacity than the conventional wall.

- Requires approximately 25% less bricks and 40% less mortar than traditional masonry

- Reduced material requirement results in considerable cost saving

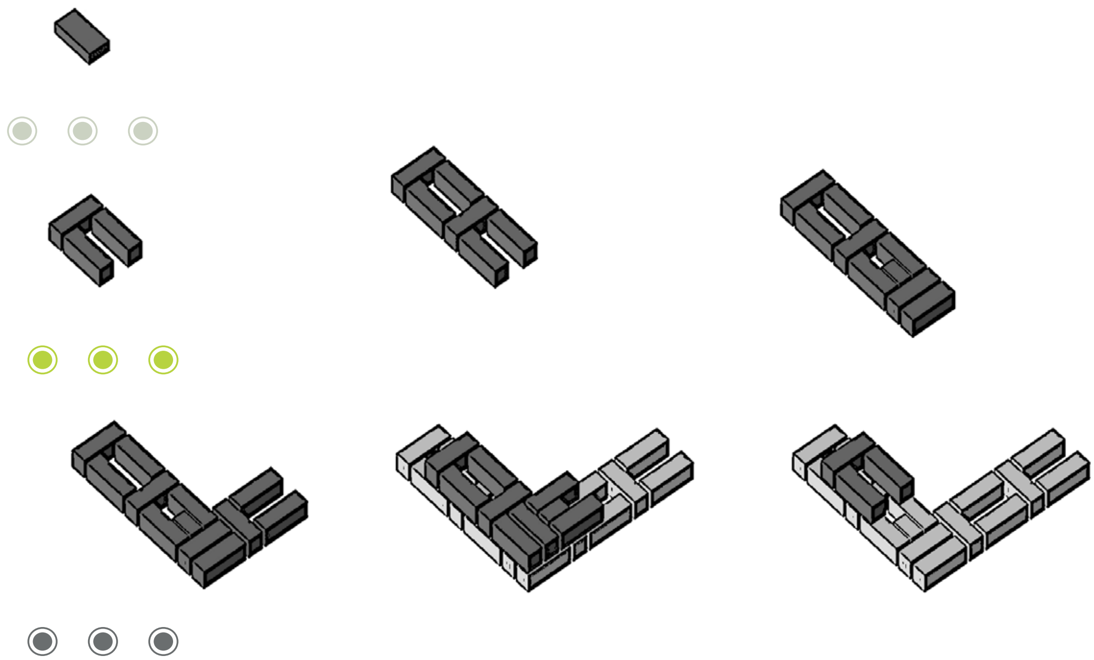
- Strength of wall is not compromised, it remains same as traditional masonry wall.

- Rat trap bond wall is a cavity wall construction with added advantage of thermal comfort. The interiors remain cooler in summer and warmer in winters.

- Rat-trap bond when kept exposed, create aesthetically pleasing wall surface and cost of plastering and painting also may be avoided.

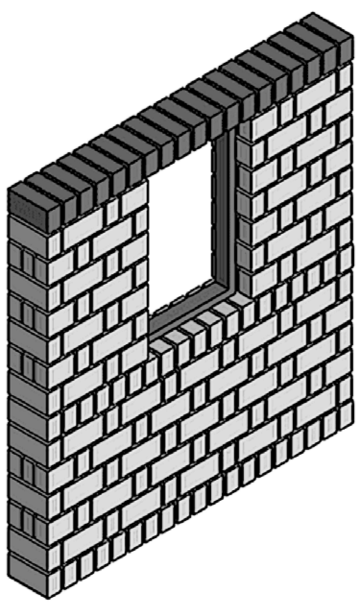
- The walls have approx. 20% less dead weight and hence the foundations and other supporting structural members can suitably be designed, this gives an added advantage of cost saving for foundation.

Wall corner detail

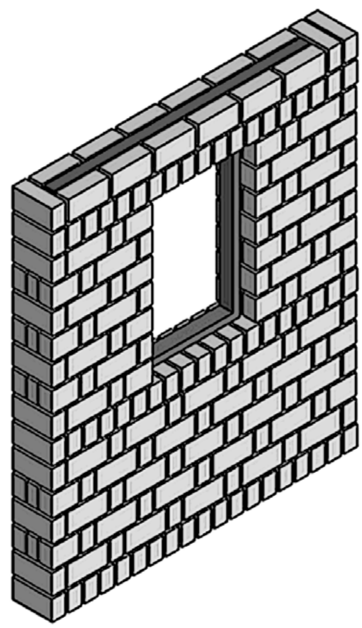


Wall Opening with Window

Step 1



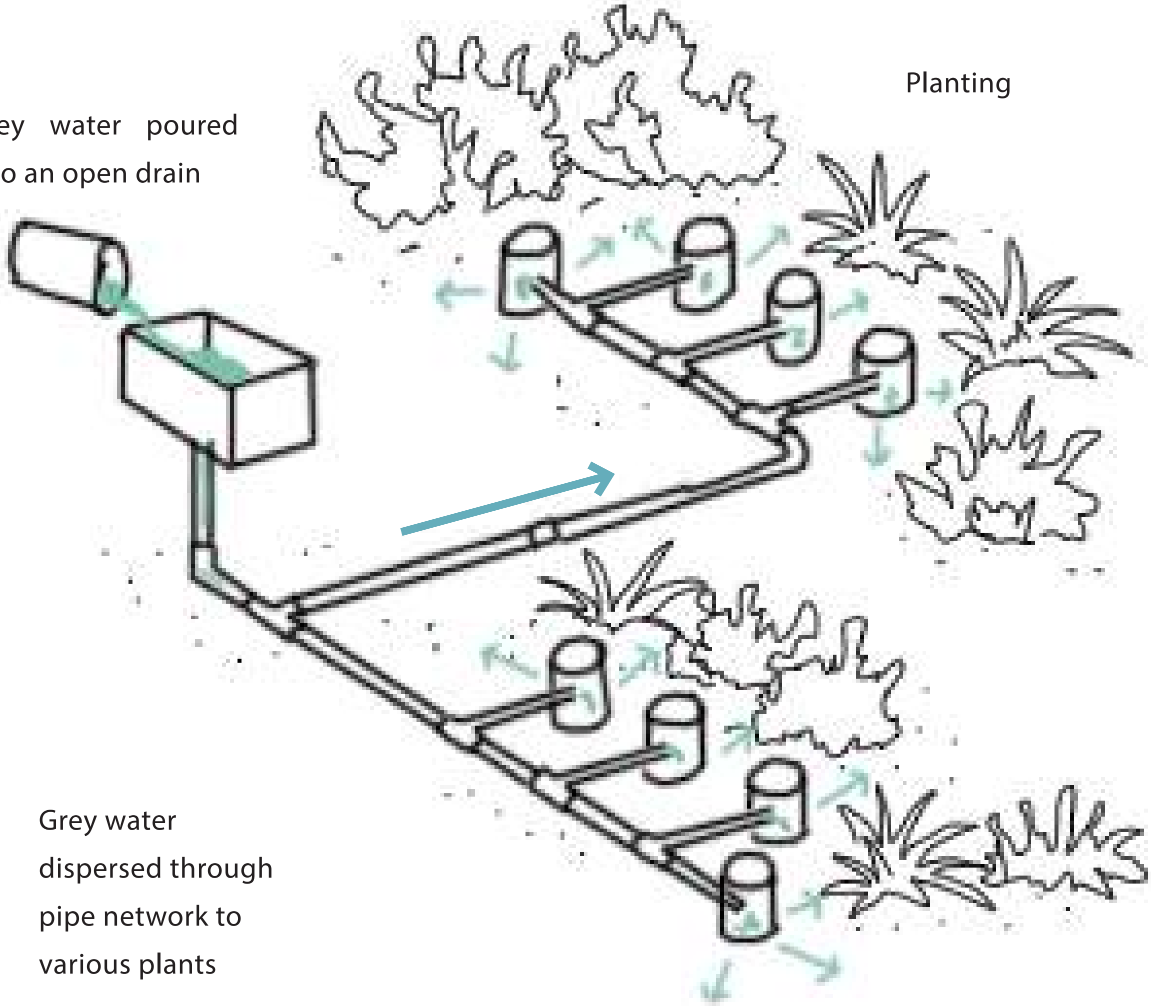
Step 2

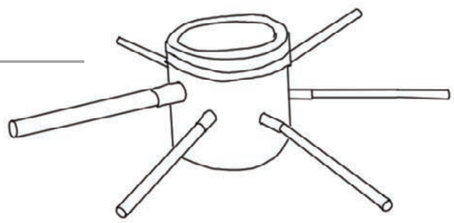


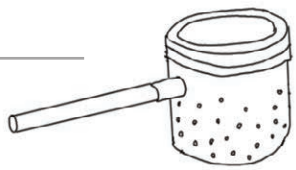
3.8. GREY WATER HARVESTING - LAUNDRY TO LANDSCAPE

Grey water is the water from sinks, showers, tubs, and washing machines, but not from toilets. It can be a great source of nutrients for irrigating plants, but often this water is simply wasted.
It's important to avoid bleach, dyes, and any unpronounceable ingredients. Switch over to greywater-friendly products that are all-natural and biodegradable, when possible.

The laundry to landscape system uses a drain and pipe system to disperse the greywater over a large area where the natural processes of bioinfiltration and bacterial breakdown of the pollutants in the greywater can occur.


Grey water poured into an open drain
Planting
Grey water dispersed through pipe network to various plants


Dispersal node using pipes


Dispersal node using a perferated bucket

3.9. GREY WATER HARVESTING - ARUM LILLY BED

An income generating opportunity for dealing with greywater is through the use of a lilly bed. by passing the greywater through a series of gravel-filled lilly beds to clean it up before irrigating various other plants. Arum lillies are quick growing plants with beautiful flowers, which can also be sold for additional income.

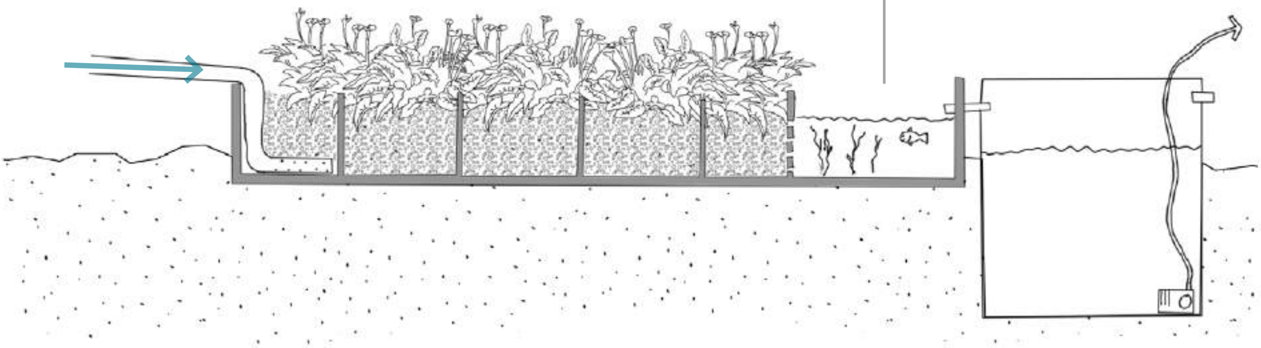
Arum lillies suck up water and release it into the air via evapotranspiration The key processes for treating greywater are not apparent to the human eye. Plant roots nurture and shelter microorganisms that not only consume ammonia, nitrogen, and phosphorous but also attack and break them down. Pollutants such as industrial chemicals, detergents, and pesticides into simple compounds that the plants can then absorb.

SECTION VIEW

Greywater from house

Series of gravel filled lilly beds

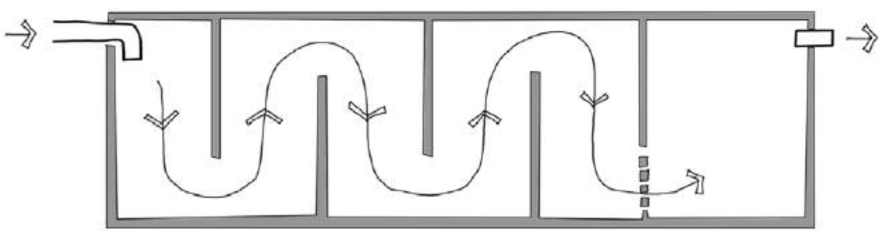
Small frog pond area (optional)



Water storage tank

PLAN VIEW

Greywater from house



Plan view showing possible lilly bed arrangements and water flow

4.1. BIO DIGESTER

A community led waste management plan in collaboration with the city can help turn waste into a valuable resource.

By separating inorganic waste from organic waste, the utility of these different kinds of waste can become a valuable resource, such as, using organic waste in biodigesters. A biodigester uses bacteria to break down organic matter and capture methane released by the bacteria. Methane, the main chemical in natural gas, is trapped and can then be burned for heating and electricity. The leftover organic solid waste can be used as fertilizer, a soil supplement or further composted.


City waste management service removes inorganic waste
Organic waste is disposed of into biodigestor
Additional income generation opporunities through recycling services

4.2. COMPOSTING TOILET

Human waste can be mixed with soil, saw dust and kitchen waste and if left to compost over time the waste will turn into a nutrient rich organic furtilizer.

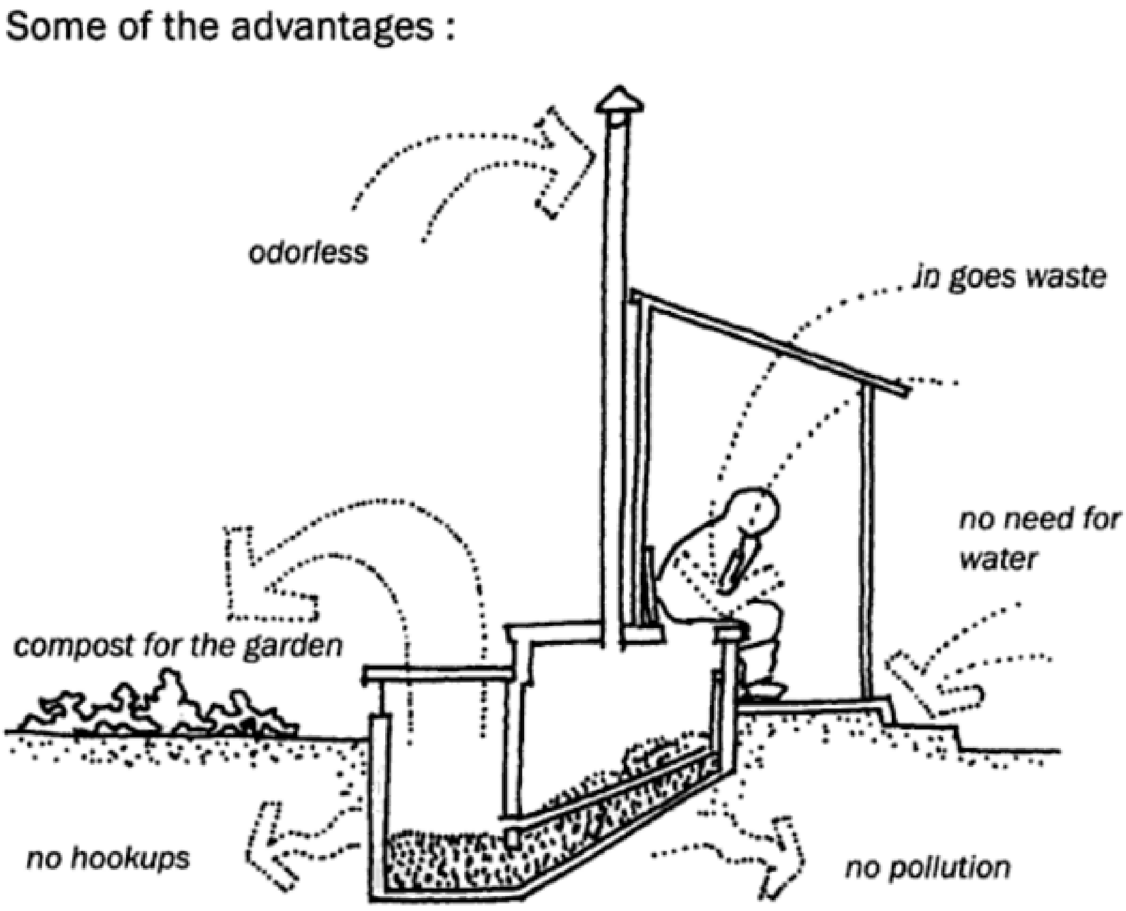
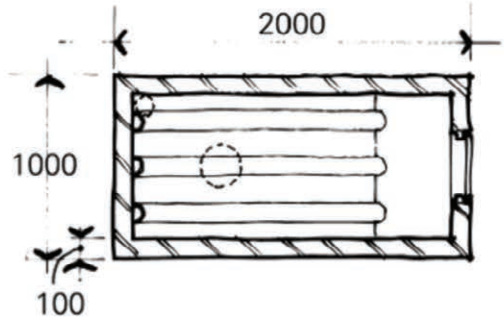
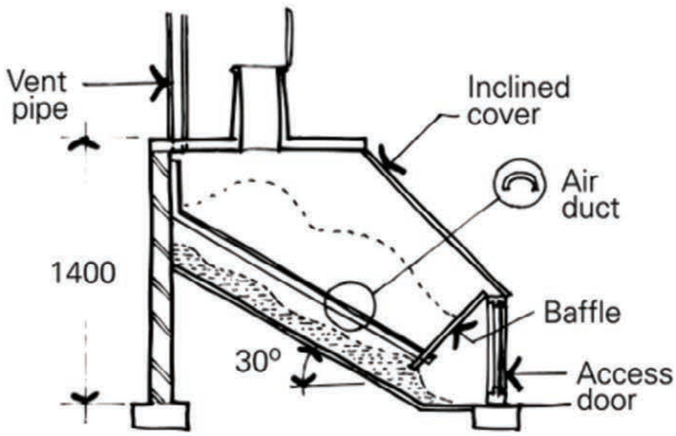


Fig 1,2, BASON Toilet Source: Bare Foot Architect

PLAN 1



SECTION 2



- Human waste once mixed with other organic waste will convert into fertilizer over 6 months.
- Incoming airducts and a ventpipe make the toilet odorless.
- The 30 degree slope of the bottom surface allows the old compost to be displaced to the bottom of the toilet by the new waste. Thus the material can be removed yearly at the lower section through the access door.

END

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