Product Design 2

Project Report : 2006

Design of a temporary One-room living for beach shacks in Goa

Application development in FRP

Submitted in partial fulfillment of the requirements
For the post graduate degree of **Masters of Design in Industrial Design**

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To the light above and within

Abstract

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The beach resonates in most of our memories
as vast expanses of sand and moving water,
as hot sun, as endless play being buffeted by the waves,
as growing overtired and being carried to bed.
It is a place quite different from everyday life because of its promise of *freedom.*

The beach as i see, is so much like each one of us because of its possibility of wilderness that like how it exists in each one of us, lies so subtle beneath its neatly groomed and guarded everyday identities.
It is here that the individuals become so acutely aware of their bodies and of their body's own tides, passions and anxieties.
It is here the body wins the struggle between nature and culture.

My project envisages to develop a space for every individual on the beach committed to their physical and emotional engagement on the beach. *An ambivalence of pleasure and pain.*

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INTRODUCTION

My initial efforts on this project commenced at a very vague scale when I started collecting thoughts on issues of large scale production of houses, its relevance in Bombay, and how the same can be used to a envision a context for which the possibilities of mass customization of living spaces can be exploited for my project.

The single largest element of our environment is that created by our houses, or by 'housing'. Different sections of society have resorted to living for various purposes temporarily and permanently under various circumstances. Living in today's world has been stretched from an idea of a shelter that can be loved and beautiful, to a grim business of facts and figures, an uphill struggle against the relentless surge of economic crisis. Today most people chose rather not to delve on human feelings.

Even in those houses which openly concern about appearances, beauty has almost been forgotten. What happens is that there is something remote from feeling, an almost disgusting concern with opulence, with the taste of the market place and with fashion.

Mumbai being a victim of its own growth witnesses the reality that disparity between the rich and poor continues to grow and it is reasonable. Land has been the most important commodity in Mumbai and often the source of much of its problems. Every year a large number of buildings in Bombay collapse, resulting in deaths and economic damage. Sometimes the damage is inflicted by the weather. The salty sea breeze and the heavy monsoon play havoc with houses in the city, giving most sea-facing walls a puffed and peeling look. Often this leads to water sepage into the walls. If this remains unchecked, water can rust and corrode steel reinforcements inside the concrete columns and seriously damage the building.

Houses of a temporary nature have often been neglected for the very reason that it is temporary. There is vast concern with the millions of homeless people on this earth, there is widespread concern with industry and technology and the ways in which these things can help the so called housing problem. It deals with the issues but glides over them. It creates a mental framework where the solutions are mechanical and unfeeling as the problems they set out to solve.

For the convenience of working on a more focused user group I would like to further draw my view points on selective situations where I would like to extend my concern for these probable contexts where I could focus my studies on.

One Room Living

- for survivors of natural calamities
- for mountaineering camps
- for slums of mumbai
- for beach shacks

… for survivors of natural calamities

This project could work towards mitigating the effects of a disaster that is towards reconstruction and rehabilitation, especially of the displaced in the disaster. One advantage of this project could be that I could explore and extend an understanding of how spaces and their implications change after a disaster and towards rehabilitation and how understanding this could be kernel to the very existence and further revitalisation of the affected mass. For study and development of this project I will have to exercise a great deal of field research in various camality affected areas, understand what holds them together and what makes them different, and develop a prototype which can be mass customised. But the project span being three months I doubt, can do justice to such sensitive an issue.

… for mountaineering camps

This project has a focussed user group where the climate and the needs of the users are very unique. I could consider a situation where the campers could actually dismantle the entire living into a carriable package and dismantle it when required or the entire dwelling elements could be factory made and transported to required locations along mountain routes.

… for the slums in Bombay

This project could enlighten me on how life has organically and naturally developed to survive in single room spaces in slums of Mumbai which in itself is worth documenting and learning from. I could attempt to nurture insights from my field study and understanding of the particular user group to substantial design potentials that could provide a better living.

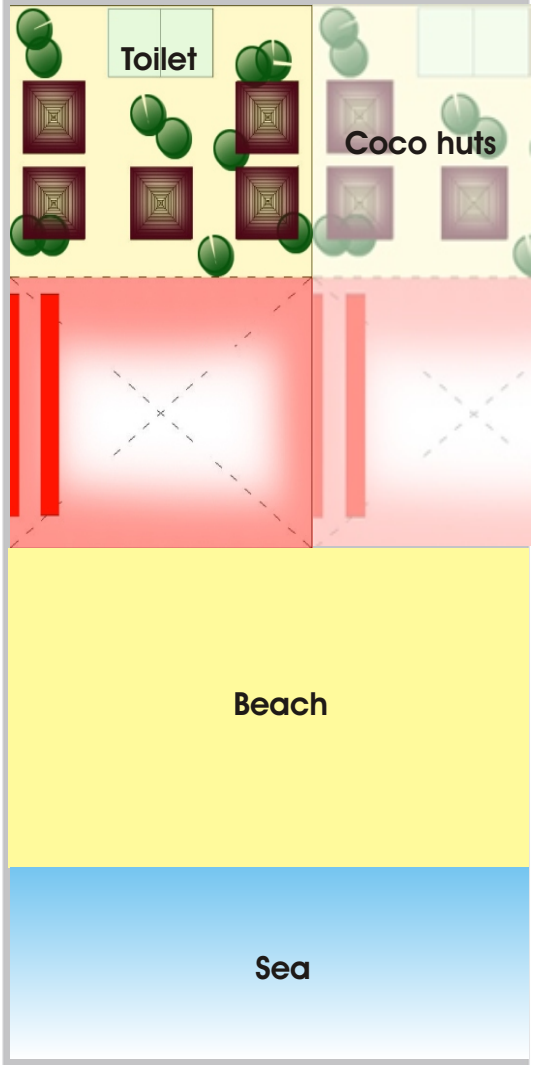
…. for beach shacks

The project had again a very dynamic flair to its existence. The owners of coastal shacks are constantly challenged by the need for a more durable shelter for tourists. The shacks have come to a prominence at the beach as an industry and the developments of these shacks have led to various conflicts and emergence of policies.

From various options discussed I realise that a beach shack could be a more feasible context for the kind of exploration I would like to further work on.

The reason being it's potential as a live project, where customising the existing shacks in a more durable material like FRP and designing it to be dismantled and propped as per use could actually be a necessity.

1.1 Understanding Beach Shacks and Coco-huts



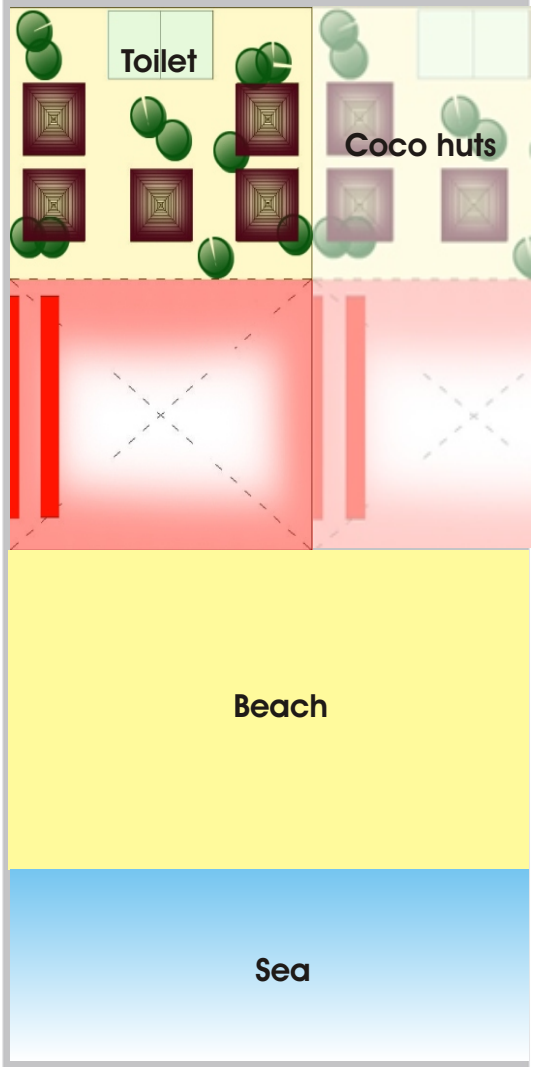
Rows of Beach shack on shore

Inside the beach shack

Hundreds of beach shacks are arranged parallel to the sea. The rear portion of each shack accommodates tourists temporarily on bamboo structures called coco-huts. Clustered in a random manner all these huts share common toilets.

Coco huts located at rear of Shack

1.1 Understanding Beach Shacks and Coco-huts



The services provided at the beach shacks have a post-modernist nature for the following reasons:

(a) blurred distinction between front and back, and inside and outside of the beach shack
(b) an informal relation between tourists and shack owners and staff; and
(c) personalised or customised service.

Shacks compete with restaurants in hotels for tourist revenue and are preferred for some of the following reasons:

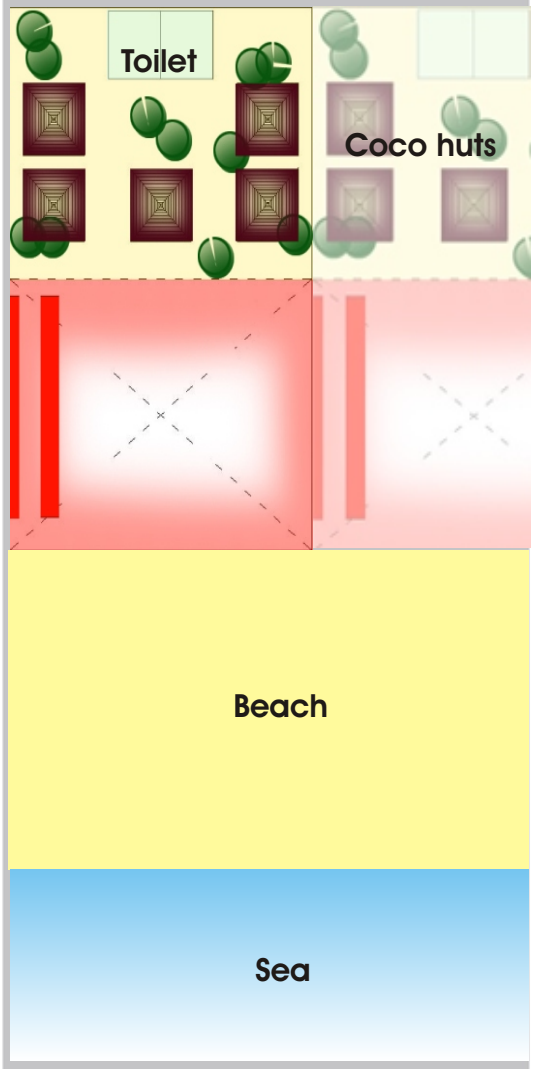
Shacks serve food and drinks on the beach itself.

Shacks relieve tourist from the heat and the sun as they are the only structures on the beach

Shacks offer a personalised service. Unlike hotels where waiters change with shifts, shacks have the same person throughout. This leads to familiarity and a bond between the client and customer, and may instil a feeling of security in the tourist who is in a foreign destination.

Being adaptable, shacks are quick to change in response to changes in demand. For instance, in North Goa shacks cater to a younger tourists with a more active night life of parties and discos. This adaptability may be attributed to the type of ownership and having close kin among the staff.

1.1 Understanding Beach Shacks and Coco-huts



- **Temporary because of CRZ rules**
- **Can exist on shore only for a period of 7 – 8 months**
- **Organic local materials are used due to temp. nature**
- **Traditional structures are weather beaten during monsoons**
- **High maintenance cost is spent every year in remaking these structures**
- **The amenities provided are meager (personal experience)**

Each coco-hut has an area of app. 4-5 sq.m

A days rent varies between 500 - 1000 I Rs.

The hut has a single room space with out any demarcation for various activities

The outdoor living areas attached to the huts are equally important.

Lighting includes a single incandescent lamp and furniture includes a 2 seater bed and occasionally an open shelf

They don't have toliet attched to them and visitors use common toilet provided by respective shacks

Quality of stay provided for the tourists is sub-standard. Even then the tourists enjoy to stay in these huts for short duration of time.

1.2 Initial Project Brief

Aim

The aim of the project
is to develop temporary habitable living units for beach shacks of Goa that would cater to short term accommodation needs of beach tourists.

To develop a one room unit that efficiently caters to the various needs of a living space

To develop a mass manufactured system which is unique in adapting to individual brilliance

To design for re arranging, mounting and dismantling the unit as per need

To make Storage of the units during monsoon season easy and efficient

To study the activity pattern of beach tourists and to understand their lifestyle

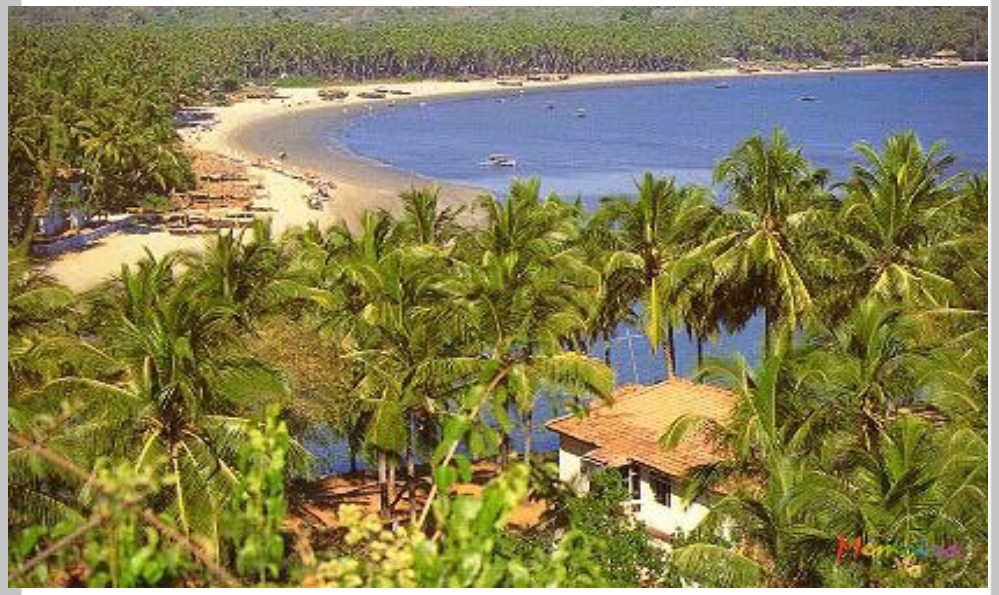
To study and analyse existing structures on the beaches which provides accommodation to tourists

To design an efficient service system with in the shack

To study and understand various industrial technologies associated with FRP that could exploited for this project

To explore more on abstract concepts of relationship of bodies to objects and environment around

1.3 History of Beach shacks



Prior to the development of tourism, somewhat similar structures on the beaches protected fishermen's boats in the non-fishing season and some provided them with shelters in which to sit and sew or repair their nets. Some were also used by beach visitors for shade. With the growth of the beach as a site for local summer recreation, beach shacks emerged from the mid-20th century on.

Beach shacks in India need to be licensed as the beach is a public area and the state is empowered to maintain this status quo. Hence, the government grants a temporary license to allow shack owners to set up beach shacks in the tourist season. Beach shacks were first licensed by the local village panchayat and in most cases favoured applications from the village itself. After 1995, the state government licensed beach shacks, more specifically, the Department of Tourism.

1.4 Ownership of shacks

To counteract political interference in this economic allocation, the High Court in Goa directed the state government to allot licenses in an impartial manner. In response, the state government started allotting licenses on the basis of a lottery system.

Every year interested candidates can take part in the lottery and obtain license to do business for that season alone. They are given cooking and bar licence and also permission to put up temporary structures during this period of time. The rule restricts the retainment of any of these structures on the shore after tourist season. However, such a system increases uncertainty and has resulted in dummy candidates contesting. Further, it leads to a market in licenses -- either the sub-letting of the lease at an additional price, or obtaining the license for speculative purposes.

System fails to guarantee a license to traditional shack owners for whom shacks were a means of livelihood

1.5 Shacks Vs Restaurants / Hotels

Beach shacks in Goa have come into conflict with hotels as they vie for the same tourist. Restaurants of hotels are one of the main sources of income for hotels. When guests patronise the shacks, this income is lost to the hotel. Hotels that have access to the beach put up structures, and organize beach parties close to the beach, and may even discourage their guests from visiting shacks. In order to attract customers, shacks come up close to the beach-front hotels.

The closer a shack is to the hotel, the more is its business potential. The location allotted to the shacks is also determined by lots, this has resulted in internal re-adjustment by licensed shack owners amongst themselves. It is the location factor that has resulted in shacks getting clustered more at the beach access points and close to hotels.

The avg. land area under shacks ranges between 40 to 300 sq. m. that for restaurants ranges between 25 to 3000 sq. M. (COASTIN Survey 2000, 2001).

CASE STUDIES

2.0 Case Studies


Wagador beach


Calangote beach


Calangote beach

A trip to Goa helped understand the situation better. Being there during off-season period, revealed certain real time problems these temporary structures faced.

The studies were conducted on four beaches Calangote, Baga, Anjuna, Wagador

2.1 Off season Condition

Every year the beach shack owners spend Rs. 60,000 to 2 lakhs for the construction of a single shack.

The Govt. of Goa forbids the retainment of any kind of temporary structures on the shore during off-season. Though most of the coco huts and beach shacks are removed completely from the shore, some of them are abandoned carelessly.

The materials used for its construction is bamboo for the structure and coconut leaf panels for the walls. The roofs are mostly thatched. Though bamboo is mostly used for two years the rest of the structure can not be retained for the next season.

Even some of the permanent restaurants on the beach with thatched roof had plastic sheets over them for protection from rain.


Wagador beach

2.1 Off season Condition

Beach shacks left to deteriorate on beach

Toilet sheds in plywood provided to tourists

Beach shacks left to deteriorate on beach

Metal frames retained for next season

2.2 Amenities Provided to tourists

Shaded and unshaded areas are provided for relaxing. Furniture for this purpose includes beach chairs and beds which are stacked and stored during monsoon season.

The Beach shack also acts as an information booth where the tourists can gather necessary information about surrounding places and events. There is usually an STD / ISD phone booth attached to the shack for the convenience of the tourists.

The shacks provide facilities for indoor as well as outdoor games. In the shaded area of the shack carrom boards and pool tables are provided.

All shacks have licence to cook and to sell alcohol. They have a bar counter with in the shack.

Quality of living provided to the tourists were sub-standard yet they preferred to stay in these huts for short duration

2.2 Amenities Provided to tourists

Private outdoor spaces attached to each hut

Interiors provided with shelf and mosquito net

Hammocks and other relaxing coir furniture

Seats and tables just outside shack for socialising

2.3 Accommodation on beach

The duration of stay of the tourists on Goan beaches varied from a couple of days to 2-3 months. During this stay the tourists would get enrolled to a shack and use coco huts which were provided to them.

The coco huts were mainly used for taking rest and for privacy. Most of the time was spend on the beach and in the shack.

Though the tourists would spend an entire day on the beach during night hours they would go to the nearest hotel or resort and come back to these shacks the next day. This they do for many days together.

This was mainly because coco huts lacked necessary security and quality of living.

Tourists chose secure areas nearest to their chosen shack for permanent stay. Need for accommodation in shacks were not properly met.

2.4 Materials of Construction

The materials used for construction of coco huts include bamboo, wood and coconut palm leaves. The frame is mostly made of bamboo. Recently metal frame work is also being used. Roof are mostly thatched. Joints are nailed and fastened by coir. For foundation the bamboo stilts are inserted into a concrete base at a depth of 1m. The mode of construction adopted is mainly for a temporary purpose. The structures are reconstructed using new material every year.

Structures on shore are usually built on stilts for fear of soil erosion and high tide condition. Every year trained crafts men are employed to built the same structure, since the material used is perishable and is inconvenient for storage for over two consecutive seasons.

2.5 Services Provided to Shacks

Water

Survey says, on avg. shacks use 8LT of water per table per day
Dependence on well water is more than 69%
Piped water accounts for 31%
(source: www.goacom.news.org)

Waste

Absence of a proper system due to temp. ownership
Pay local village panchayat for garbage collection
There is no collection from shacks on beach
Practice of dumping waste into pits of sand is prevalent

Cooking

License is provided for cooking and selling alcohol

Electricity

Provided for tourist season

2.6 Location of Shacks on Shore

Beach shacks are located at CRZ area of Goan Beaches at a distance of hardly 15 - 20m from HT line.

CRZ III

1981 - beaches had to be kept clear of all activities up to 500 m from the highest water line

Environment Protection Act of 1986 coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 m from the High Tide Line (HTL) and the land between Low Tide Line (LTL) and HTL, as CRZ.
Clause 4 of the terms and condition 1998-99, state that shacks should not come up in front of any hotel property.

GUIDELINES FOR DEVELOPMENT OF BEACH RESORTS/HOTELS IN THE DESIGNATED AREAS OF CRZ-III FOR TEMPORARY OCCUPATION OF TOURIST/VISITORS, WITH PRIOR APPROVAL OF THE MINISTRY OF ENVIRONMENT & FORESTS.

flattening of sand dunes is prohibited

permanent structures are not allowed

construction of basements is not allowed

construction will not adversely affect free flow of ground water in that area

The overall height of construction – 9m – 2 floors

Ground water shall not be tapped within 200m of the HTL

Consisitency with the surrounding landscape

USER STUDY

3.0 User study

Persona 01
Terry and Vandana

Duration of stay in Goa - 2 weeks

Holiday plan - As of now have been staying in shack for 2 days. Haven't decided what to do the next day. Have plans to see other parts of Goa and come back if time permits

Feed back

Was approached by many hustlers while walking along the beach, some of them were very persistent

People of Goa are very kind and helpful

Heard that there are bag snatchers around. So have left valuables in hotel room.

We don't want to carry valuables on beach because then we cant go swimming together. One has to look after belongings if the other has to take a dip

We come to shacks on the beach early in the morning until quite late at night and spend the whole day here. For the past two days we have also rented a coco-hut adjoined to the shack.

Mosquitoes in the coco huts trouble a lot. There is no switch board to plug a electrical mosquito repellent. Getting a mosquito coil is too tedious.

Persona 02
Shelly

Duration of stay in Goa - 1 week

Holiday plan - Stayed at a guest house near by. Rented a coco hut after coming to the beach. Personal belongings are left behind in the guest house.

Feed back

The shack feels safe since it is by local people and more of an extension of a house rather than a restaurant

Usually don't come to the sea at night because it is off season and there is very little crowd. Getting out in the dark, normally for long walks can be dangerous. You can be taken for a ride or swindled or anything.

Prefer to stay in the shack because within the past four days have grown familiar with the people in the shack. But they have a common toilet which is quite inconvenient for use at night.

The locals are nice people and should try and chat to one.

I visited and stayed at the guesthouse and later moved and stayed in the beach huts. I liked both the places. If you want somewhere close to the beach, the beach huts are ideal and good value.

Persona 03
Rose Bromham

Duration of stay in Goa - 4 days

Holiday plan - First day in Goa. Stays at a hotel near by. Have spend the whole day on the beach. And would get back to hotel in the evening.

Feed back

One can start the day with breakfast then splash in the waters the whole day or just laze on the beach and return to one's hotel late in the evening.

Some shacks are well quipped with beach beds, beach chairs, beach umbrellas, masseurs, etc. These places also provide some information about the happenings around the locality.

Towards the evening just before sunset the sky fills with magical wonder, a sight that has left some spellbound.

It is a must see phenoenon for anyone visiting Goa and if one is lucky enough one might be able to see the sun being swallowed by the sea. And to end the day one can dine at the beach at the shack of one's choice.

Each shack has its own type of music, but at request music also played.

Feed back

Persona 04
George, Reyan and Mevin
(Beach Shack staff)

The All Goa Shack Owners' Association (AGSOA)is an active organistaion of beach shack owners and fight for their rights.

Every year applications are invited for the shacks in August and gives a licence to construct temporary shacks for tourist season.

For a single day stay the coco huts is rated at a range of Rs. 800 - 1800 .

Most of the foreign tourists spend the whole day on beach and get back to their hotel rooms for the night.

Shack interiors cant compete with hotels. But they adore the kind of environment around the shack.

Shacks provide adequate shelter to those who might want stay away from the scorching sun and enjoy the sea breeze.

Eligibility criteria require applicants and their families to be unemployed. Still they have to invest huge amount into business Every year Rs. 60,000 to 2 lakhs is invested for the construction of shacks.

People from Bombay and Bangalore come to these areas during season and purchase shacks to hold yoga sessions… they make more money than local people

Beaches have hundreds of shacks aligned in a linear stretch, so there is a need to attract crowd during tourist season.

Only few bamboo members is restored for next season. Mostly the entire structure is reconstructed.

3.1 Inference of User study

Tourists

Emotional Needs

Sun shade and sand
The proximity of the shacks gives them an experience of living on the beach which is unique

Relax in huts
The huts are close by to the sea and so can retrieve conveniently at any point of time to your abode with out worry of travel

View to sea
Located so close to the sea that view to the sea is unhindered at all times

Romantic experience

Functional Needs

Security
Absence of proper security for belongings. Since the huts are with in area of a shack which is an extension of the house of beach owners personal safety is of little concern.

Facilities with in hut
The quality of amenities provided to tourists is sub-standard

Mosquitoes

Ventilation

Attached toilets

Beach Shack Owners

Emotional Needs

Attract crowd so that they stay over
There is a need to improve facilities provided to tourists as the competition between shack owners are increasing.

Distinct and loud design
Design should be able to attract crowd at a distance

Security of customers
Customers should feel safe to stay at night

Functional Needs

Free of maintenance

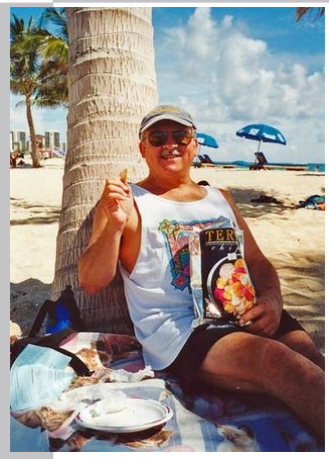
Easy to store, arrange and dismantle

Increased life cycle

Max. use of available plot

Attached toilets

3.2 Understanding Beach life through Scenarios



Individual Back pack tourists come to beaches of Goa and stay for 1-3 months together.

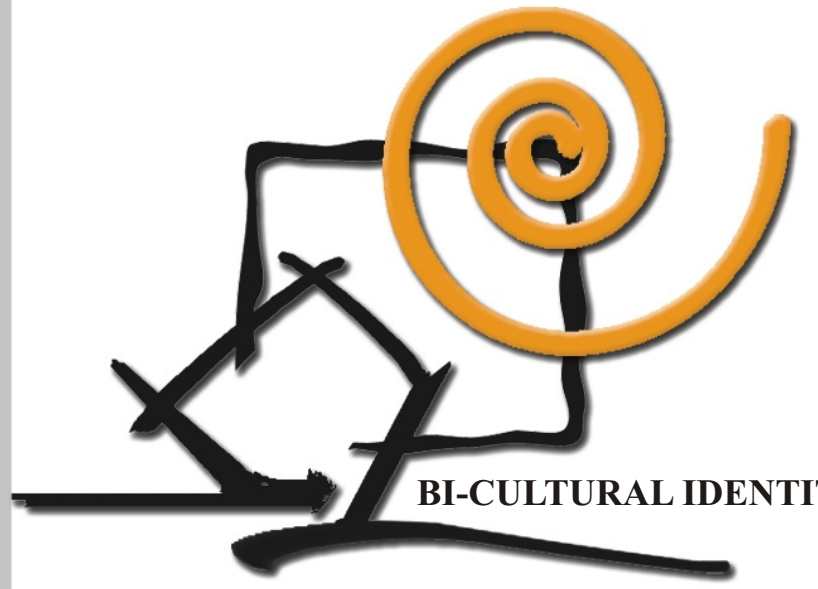
Such tourists book coco huts and stay for longer periods on their own. They eat food from the shack and use the coco hut during the day hours. They would go around goa but return to the shack in a day or two.

Group of two come for vacation to goa and stay for a duration of 4 days to 2 weeks

These tourists have usually come down on a booked tour trip to Goa and have a planned vacation for two weeks. They wouldn't stay at a single beach for more than 4 days.

Larger groups stay do not stay for more than two days at a stretch

(Source): experience of beach shack owners



BI-CULTURAL IDENTITY

4.0 Bi-cultural Identity

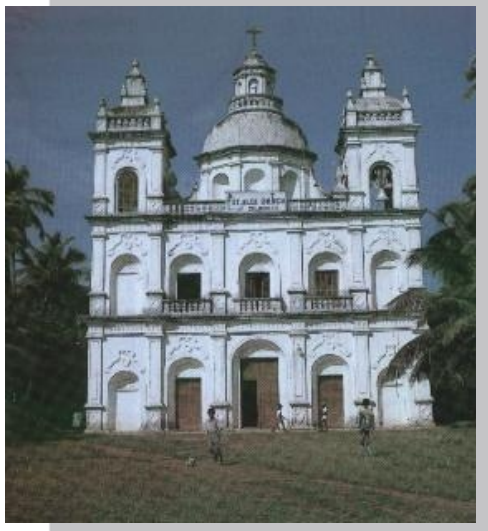
4.1 Bi-culturism in Goa

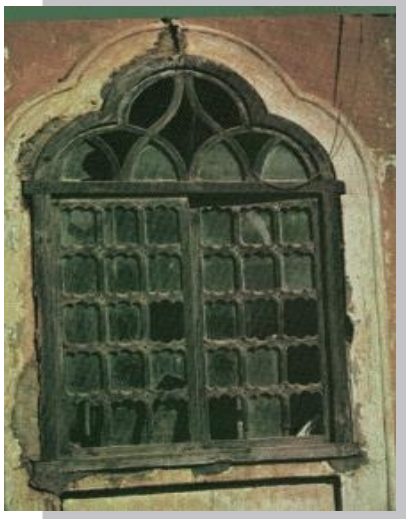
Beach shacks are essentially an evolution of beach huts which served as dwellings for fishermen settlements on shore. With foreign invasion the shores of costal regions especially Goa were taken over by a completely new-local culture. Some where the cross between the two cultures have been merged to form a unique whole.

All cultures have generally been evolving by borrowing from other cultures that they come across. Here in Goa, the cultural influence and exchange have been led by foreign culture domination and subsequent sub-ordination of local culture.

Beach huts on shore is a foreign idea that has been accepted over time in Goa with the promotion of tourism. Some where the present product looks bland and doesnt carry a belong-ness to Goa. There is a need for assimilating this foreign product with local manifests, notions and concepts.

As part of my project Im trying to understand what product precedents beach huts have in non-local culture and what could make it a **" Goan beach hut “**





4.2 Understanding product precedents

Non-local beach huts were observed and analysed

Observations

1. Huts are arranged repetitively in a linear pattern
2. Roofs are of sloping nature made of the same material as hut
3. Bright colors are used
4. Stilt type of construction is adopted

Non-local beach huts were observed and analysed

Observations

1. Roofs are made of temporary materials
2. Process of assembly is visible in form
3. Structures are open to the sea to take the sea breeze in and for max. view to sea

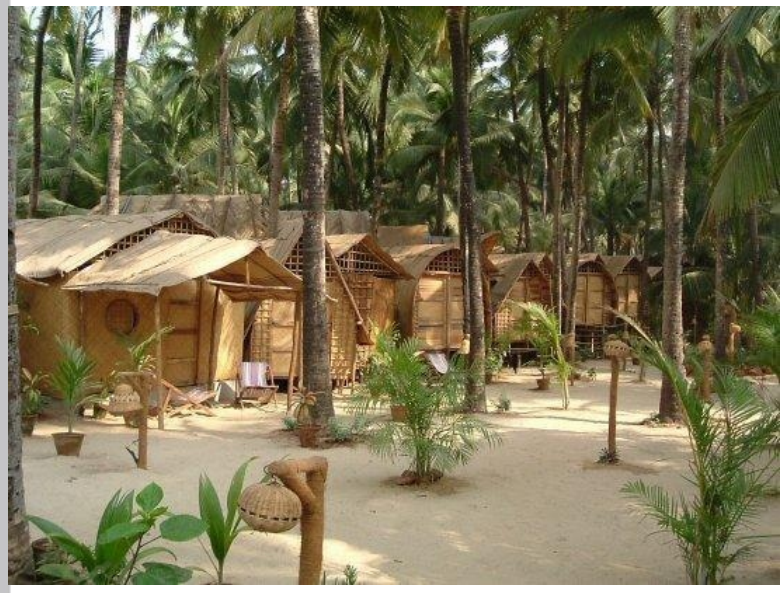
4.2 Understanding product precedents

Non-local beach huts were observed and analysed

Observations

1. Out door space to view and experince the beach
2. Bright colours are used
3. Stilt type of construction is adopted

Local beach huts were observed and analysed



Observations

1. Mainly made of thatched roof and bamboo pole construction
2. Semi-open verandah in front to sit ad relax
3. Stepped roofs are used for huts
4. Bamboo poles are used to raise structure above the ground

4.3 Goan-ness of Goa

Goan houses were observed and analysed

Observations

1. Bright colors, mostly red and even blue is used
2. They have steeped sloping roof
3. A semi open verandah space which becomes an area for a lot of activities
4. Broad frames for openings stepped sloping roof

4.4 Inference

The exercise helped observe the following manifests

Hut-ness of a beach hut
Goan-ness of Goan built structures
Temorary-ness of temporary structures

Hut-ness of a beach hut

Notions are associated

Thatched sloping roof and bamboo poles. How they are tied with ropes at joints.
The floor being raised above the ground by means of stilt type of construction
The experience of sitting on a deck drinking chilled bear and the sea breeze blowing through your hair

Goan-ness of Goan built structures

Notions are associated

Bright colors mostly red and even blue is used
Steeped sloping roof made of traditional mangalore tiles
A semi-open verandah space which becomes an area of interesting activities - the node of life
Broad frames are used to define openings
Use of stepped sloping roof

Temorary-ness of temporary structures

Use of rustic materials
The joints are visible giving away the 'process of its making'

MATERIAL STUDY

5.1 Composite Manufacturing Technology

Composite materials have been gaining important industrial and commercial applications world widely and they were developed because they can offer unique properties (lightweight, high strength and stiffness, chemical and corrosion resistance, tailoriable electrical and thermal properties, etc.) which no single homogeneous structural material could be found that had all the desired attributes for a given application. However, due to its composition complexity of a composite material, its final properties are not only depending on the properties of component materials (matrices, reinforcements, fillers and additives) used, but also significantly on the way it was fabricated as well as equipments, technologies and people skills.

Although the fabrication and application of composite materials by human being could be tracked back to ancient times conceptually, the technologies for fabricating composite materials or advanced composites we refereed to nowadays are young and still under development and improvement. Compared to conventional homogeneous materials (such as metals, plastics etc.), the manufacturing techniques for composite materials are more demanding and more sophisticated. New tools, new techniques and highly skilled workers are required.

Different manufacture processes used for this

Filament Winding
Hand Lay up / Spray up
Pultrusion
RTM, VARTM
Sandwich Construction
Thermoforming
Vaccuum Bagging
Compression Molding Extrusion

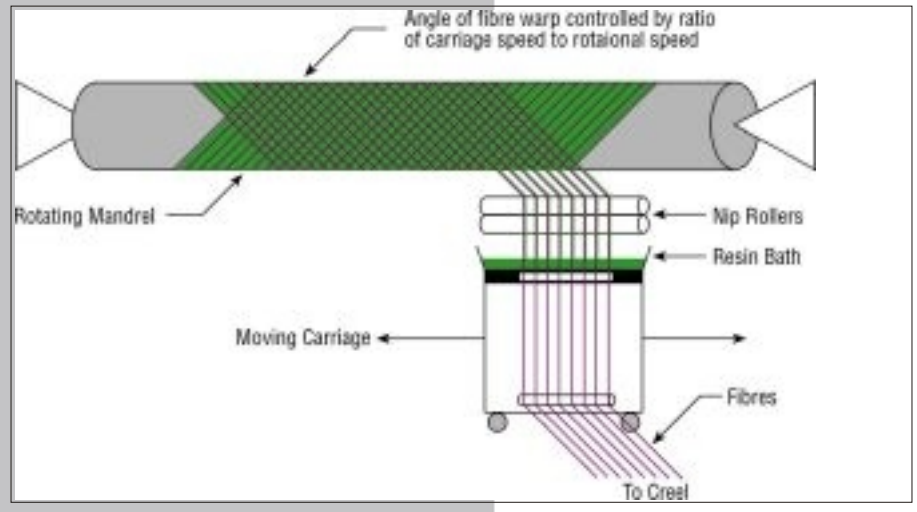
5.1.1 Filament Winding

This process is primarily used for hollow, generally circular or oval sectioned components, such as pipes and tanks. Fibre tows are passed through a resin bath before being wound onto a mandrel in a variety of orientations, controlled by the fibre feeding mechanism, and rate of rotation of the mandrel.
While filament winding machine design varies with part geometry, the basic filament winding process concept is described in the following schematic.

The fibres are impregnated with resin (by immersion, or by passing over a resin-wetted drum, or by injection into the die) before being led to a feed eye where a controlled band-width is set prior to positioning on the mandrel.

Fiber tension is critical to the operation of a filament winding machine. The fibers are supplied on creels and it is normal to have fiber tensioners (closed-loop controlled servo-driven "dancers") in the feed line. The tension required is dependent on the type of fibre, the part diameter and the winding pattern selected. The tension directly affects both fibre volume fraction and void content and, in turn, influences the strength and stiffness of the composite part.

Once the fiber package is positioned the resin is taken to full cure, often by heating in an oven. The final stage is mandrel removal to leave the desired hollow component. This may be achieved by hydraulic rams for extracting steel mandrels. For more complex structures, the mandrel may be a low melting point materials (eg metal alloy) or a water soluble salt (leachable plaster) which can be washed out or a collapsible rubber or a non re-useable foam. In some cases, where a liner is required for minimal gas permeability the liner may also function as the mandrel and hence not need to be removed.



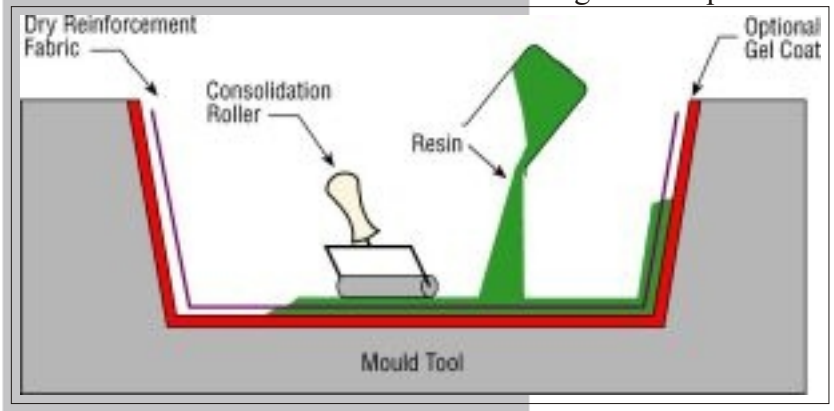
Typical Applications:

Chemical storage tanks and pipelines,
gas cylinders,
rocket motors,
launch tubes,
pressure vessels,
drive shafts and
Fishing rods and missile cases

5.1.2 Hand lay up / Spray up

Typical Applications:

most of aircraft composite parts,
boat hulls and decks,
RV components,
truck cabs and fenders,
Wind-turbine blades etc



Hand Lay up

Hand layup is an open contact molding in one-sided molds are the lowest-cost and most common processes for making fiberglass composite products..

In a typical open mold application, the mold is first waxed and sprayed with gel coat. It then may be cured in a heated oven at about 120º F. In the spray-up process, after the gel coat cures, catalyzed resin (usually polyester or vinyl ester at 500 cps to 1000 cps viscosity) is sprayed into the mold, along with chopped fiberglass. A chopper gun chops roving (usually E-glass) directly into the resin spray, so that all materials are simultaneously applied to the mold. Using low-styrene and suppressed-styrene resins, fillers and high-volume/low-pressure spray guns or pressure-fed resin roller applicators helps reduce emissions of volatile organic compounds.

In hand lay-up processing, fiberglass (typically E-glass) continuous strand mat and/or other fabrics such as woven roving are manually placed in the mold. Each ply is sprayed with Catalyzed resin (1000 to 1500 cps) and the resin is worked into the fiber with brushes and rollers to wet-out and compact the laminate.

Fiber content can be increased by up to 50 percent by curing the part in a vacuum bag, using 2 psi to 14 psi vacuum pressure and cure temperatures under 350º F. Vacuum-assisted resin transfer molding (VARTM) and infusion molding systems are gaining favor with open-mold processors wanting to cut volatile organic compounds emissions. The applied vacuum compacts the preform and helps the resin to penetrate and wet-out the fiber preform. Fiber content up to 70 percent has been reported.

Spray up

Spray-up is an open-molding composites fabrication process where resin and reinforcements are sprayed onto a mold. The resin and glass may be applied separately or simultaneously "chopped" in a combined stream from a chopper gun. Workers roll out the spray-up to compact the laminate. Wood, foam or other core material may then be added, and a secondary spray-up layer imbeds the core between the laminates (sandwich construction). The part is then cured, cooled and removed from the reusable mold.

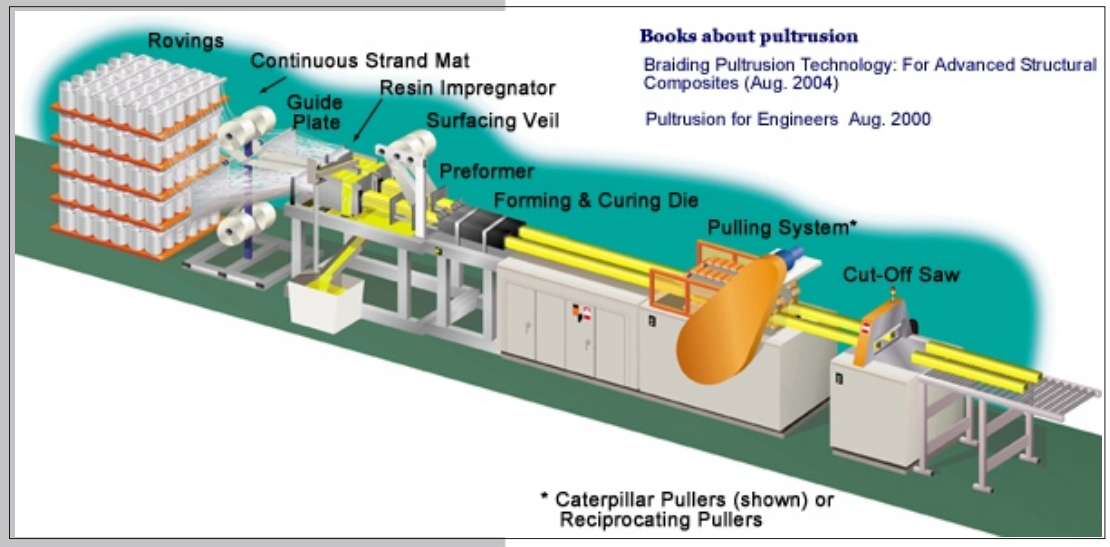
Spray layup has very little application in aerospace. This technology produces low specific strength structures which usually do not belong on the end product. Spray layup is being used to join back-up structures to composite face sheets on composite tools.

5.1.3 Pultrusion

Pultrusion is a manufacturing process for producing continuous lengths of FRP structural shapes. Raw materials include a liquid resin mixture (containing resin, fillers and specialized additives) and reinforcing fibers. The process involves pulling these raw materials (rather than pushing as is the case in extrusion) through a heated steel forming die using a continuous pulling device. The reinforcement materials are in continuous forms such as rolls of fiberglass mat or doffs of fiberglass roving. As the reinforcements are saturated with the resin mixture ("wet-out") in the resin impregnator and pulled through the die, the gelation (or hardening) of the resin is initiated by the heat from the die and a rigid, cured profile is formed that corresponds to the shape of the die.

While pultrusion machine design varies with part geometry, the basic pultrusion process concept is described in the following schematic.

The creels position the reinforcements for subsequent feeding into the guides. The reinforcement must be located properly within the composite and controlled by the reinforcement guides.
The resin impregnator saturates (wets out) the reinforcement with a solution containing the resin, fillers, pigment, and catalyst plus any other additives required. The interior of the resin impregnator is carefully designed to optimize the "wet-out" (complete saturation) of the reinforcements.

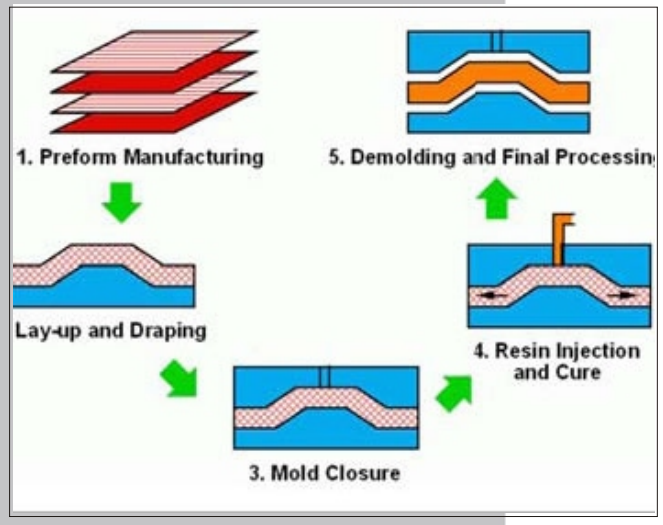


On exiting the resin impregnator, the reinforcements are organized and positioned for the eventual placement within the cross section form by the preformer. The preformer is an array of tooling which squeezes away excess resin as the product is moving forward and gently shapes the materials prior to entering the die. In the die the thermosetting reaction is heat activated (energy is primarily supplied electrically) and the composite is cured (hardened).

On exiting the die, the cured profile is pulled to the saw for cutting to length. It is necessary to cool the hot part before it is gripped by the pull block (made of durable urethane foam) to prevent cracking and/or deformation by the pull blocks. Two distinct pulling systems are used: a caterpillar counter-rotating type and a hand-over-hand reciprocating type.

In certain applications an RF (radio frequency wave generator) unit is used to preheat the composite before entering the die. When in use, the RF heater is positioned between the resin impregnator and the preformer. RF is generally only used with an all roving part.

5.1.4 RTM / VARTM

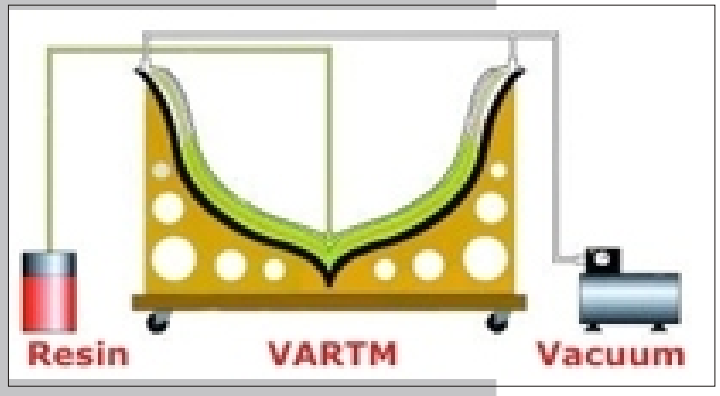


Resin Transfer Molding (RTM)

RTM is a particular useful manufacturing process processes that use liquid resin to impregnate the stationary fibrous preform. During the RTM Process, the preform is placed into the mold cavity, the mold is closed and the resin is injected into the cavity under pressure. The mold with the preform is often put under vacuum so that the vacuum removes all the entrapped air in the preform and speeds up the RTM process. Once the liquid resin fills the mold cavity, it cures, during which the resin hardens due to the formation of polymeric network forming the matrix of the composite, allowing the part to be de-molded. Typically thermoset polymers of Epoxy, Vinyl Ester, Methyl Methacrylate, Polyester or Phenolic are used with fiberglass, carbon fiber Arimid and synthetic fibers reinforcements either individually or in combination with each other.

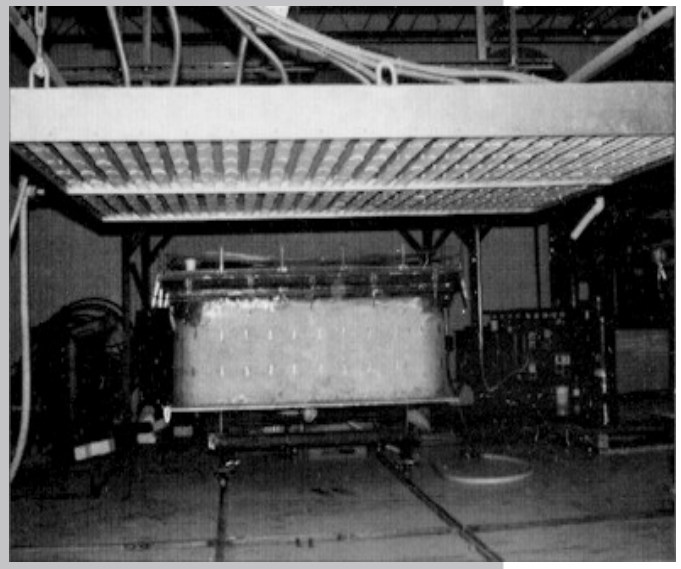
This technique is well known and has been traditionally applied to moderately large parts in various application. It allows one to obtain even very complex neat-shape parts with good surface finish, in many cases at reasonable production rates. The fiber architecture, permeability of the preform and the fabric crimps, resin viscosity, temperature of operation, have an influence on the wetting of the fabric. Careful process design is needed to obtain a repeatable high quality product.

Vacuum assisted resin transfer molding (VARTM)



VARTM is a single sided molding process where the dry preform (reinforcement or coring materials) is placed into the mold, a cover (or a vacuum bag) is placed over the top to form a vacuum-tight seal. A distribution medium (a mesh) is used and laid on top of the top release fabric to help maintain an even distribution of resin and facilitate the flow of resin through the thickness of the panel. The low viscosity resin typically enters the preform through resin distribution and vacuum distribution lines with the aid of vacuum. In VARTM process, the flow of resin occurs in plane as well as in the transverse directions to the preform. The permeability of the preform, fiber architecture and fabric crimp have an influence on the wetting of the fabric.

5.1.5 Thermoforming



Images from Seagull, a thermoforming machine maker

Thermoforming is a molding process used to form sheets of plastic to a mold surface by using heat and force consisting of vacuum and/or pressure. This technology appeared to to have applications during the prime of thermoplastics. Thermoforming is a downstream plastic process, however it is often viewed as an alternative to injection molding in numerous markets and end-uses.

Thermoforming is used primarily in low-cost applications for the simple embossing of thin plastic sheet and cannot be used to form as rigid shapes as vacuum forming is capable of. Thermoformed plastics are invariably thermoplastics because thermosetting plastics assume their final shape through heat and so can not be moulded with this process.
Familiar products manufactured by thermoforming include: yoghurt pots and simple trays. The plastics that are used in thermoforming include: acrylic, low density polyethylene (LDPE) and crystalline polyester (CPET).

There are three types of thermoforming molds:

Machined Aluminum Molds-- are typically built for shallow parts with small draw ratios. Male or female molds and vacuum-form or pressure-form molds can be machined aluminum molds. They can be textured and may offer features such as loose cores, pneumatic cores, and inserts.

Cast Aluminum Molds -- are cast at a foundry from a machined pattern from a composite material and typically are built for parts with large draw ratios

Composite Molds --For prototyping and short production runs, cost-efficient composite materials are used for mold construction. These molds produce parts that are to be evaluated for fit, form, and function and may be modified to evaluate possible design changes. These molds are for vacuum-forming only and are not temperature controlled. These molds have a limited life.

Typical Applications:

Large panels, housings, enclosures, and similar parts, children's swimming pools, small boat hulls,`Halloween masks, disposable SOLO cups, ice cube trays, refrigerator door liners, cookie or donut trays, and Glad-Ware food containers

5.1.6 Compression / Extrusion

Compression

In compression moulding, two matched (usually steel) mould halves are mounted in a (normally hydraulic) press with movement limited to the axis normal to the plane of the mould. This process tends to be associated with a variety of materials, including (but not a limited list):

prepreg continuous fibres in epoxy resin
prepreg short fibres in polyester resin (sheet moulding compound - SMC)
dough moulding compound (SMC)
bulk moulding compound (BMC)
prepreg short fibre in a thermoplastic matrix (glass mat thermoplastics - GMT)

The moulds may be heated or the composite may be preheated and formed in relatively cool moulds. A limitation on the process is the uniaxial force applied - as a consequence while horizontal surfaces are subject to compression loads as the component surfaces change to vertical there is little or no component of the force acting to consolidate the material in that plane. Further near vertical surfaces may be subjected to wrinkling during mould closure. These issues may be resolved by the use of rubber-block moulding or hydroforming (pressurised liquid contained in a flexible membrane) wholly or partially substituting the male mould half.

Extrusion

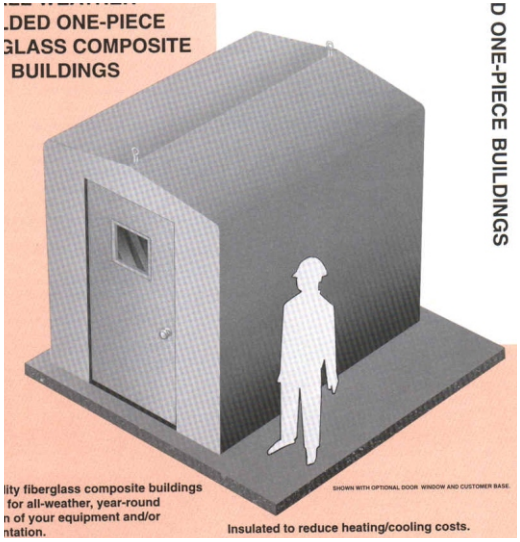
A thermoplastic process whereby pellets, granules, or powder are melted and forced through a die under pressure to form a given, continuous shape. Typical shapes extruded are flat films and sheets, filaments and fibers, strands for pelletizing, and webs for coating and laminating. Also used for forming composite preformed materials from mixtures of a matrix powder and short fibers suitable for MMCs. Widely used for continuous production of film, sheet, tube, and other profiles; also used in conjunction with blow molding. Thermoplastic or thermoset molding compound is fed from a hopper to a screw and barrel where it is heated to plasticity then forwarded, usually via a rotating screw, through a nozzle possessing the desired cross section. Production lines require input and takeoff equipment that can be complex.

Low tool cost, numerous complex profile shapes possible, very rapid production rates, can apply coatings or jacketing to core materials (such as wire).

Familiar products manufactured by extrusion include: pipes, ingot, guttering, window sills and insulation on wires.

Cabins in FRP

Cabins in FRP



Beach huts and Cabins in FRP - Image Board

5.2 Image Board

Construction application of FRP - Image Board

Automobile application of FRP - Image Board


SMC toilet compartment


Panels of heavy trucks


NVH Covers with in situ Foam Moulding


Transmission Cover for UV


Train interiors: Ceiling:
wall linings and luggage space panels


Engine Hood for Commercial Vehicle


Composite Floor

DESIGN DEVELOPMENT

6.1 Initial Area Calculation

Based on initial vision and study, spaces were organized to understand area required for the project. An ideal plan was developed on its basis

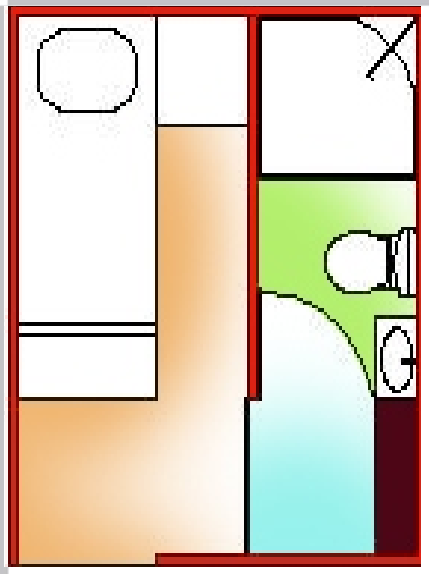
Design Concept

Sun, shade and sand
A 3d space that is open to sun and provides necessary shade at the same time. Having a semi-private sand bed of it own which further extends itself to the shore

Segregating secure and insecure area
There is a set of amenities like storage and dress that can be segregated as a more private area and the bed space can be a non-secure semi private area. This distinction can help detail design better

Max view to sea
The potential to watch the sea at a distance form the hut is necessary

Exploiting sea breeze for design
Understanding the direction of sea breeze and to place openings to exploit it for better ventilation.

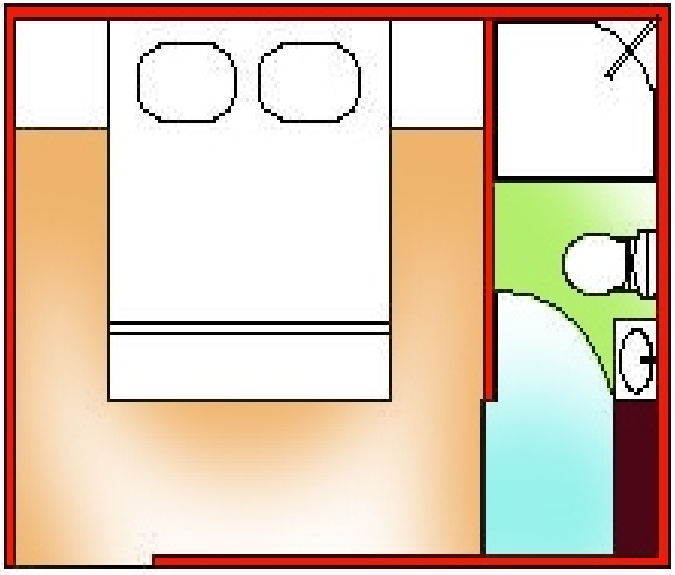


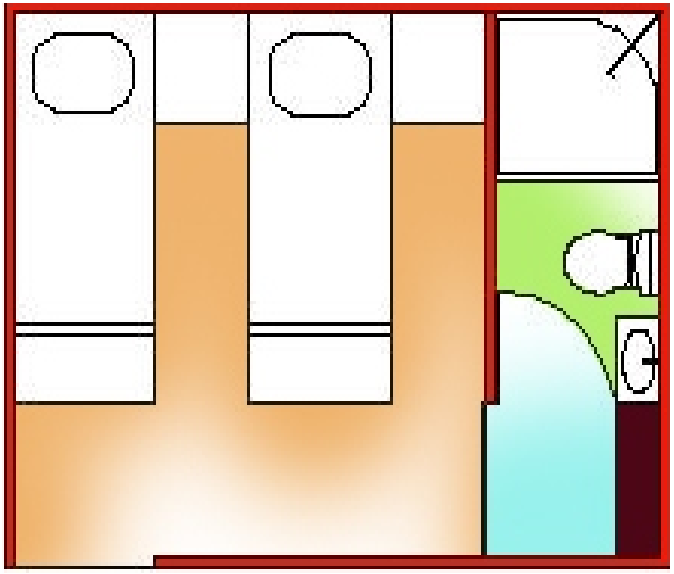
Type I - Single Occupant
2.7m x 3.0m (9'x 10')

Drawbacks

Failed to address the essence of short term accommodation. Even the smallest plan occupied more area than the existing structures which is a double occupant

Type II - Double Occupant
3.0m x 4.2m (10'x 14')





6.2 Idea Sketches

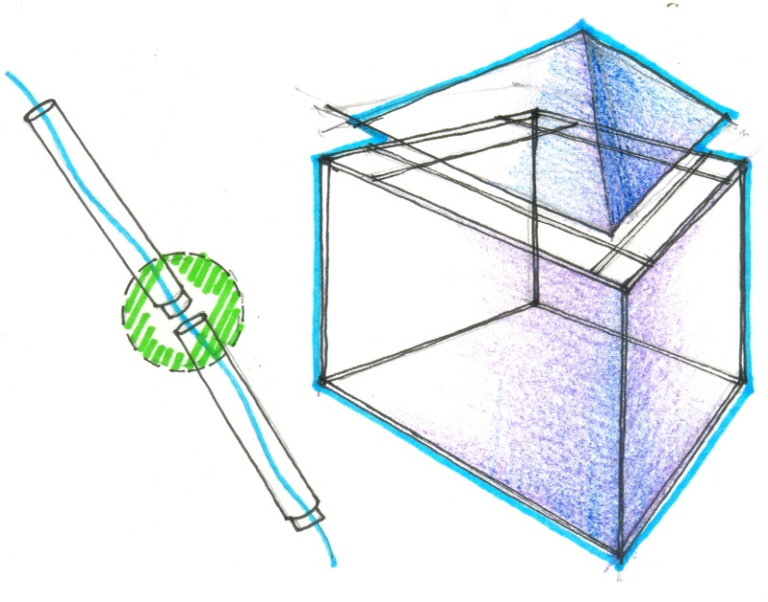
Initial Idea Sketches were done classified into four major types

01 **Collapsible tubular sections that can be developed into modules**

02 Developing a single module that can be used for both structure and furniture

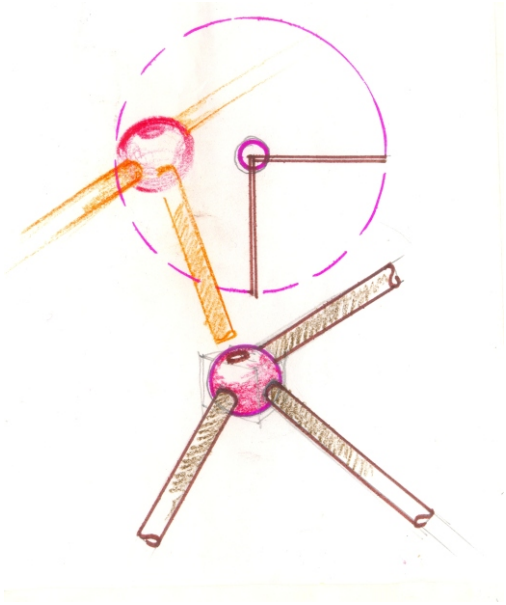
03 Integrating tensile roof along with FRP structure

04 Double storied design solutions



IDEA SKETCH 01

Tent made of FRP tubes which can fit into each other and can be held in position by a string of elastic that passes through it



IDEA SKETCH 02

Three spokes in three cardinal directions make a unit. The unit are joined together to make main frame of the hut.

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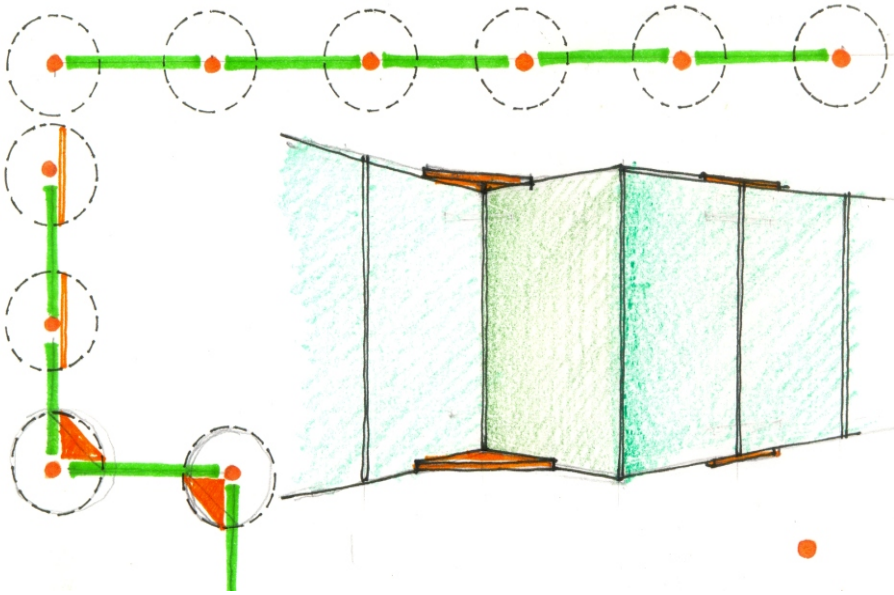
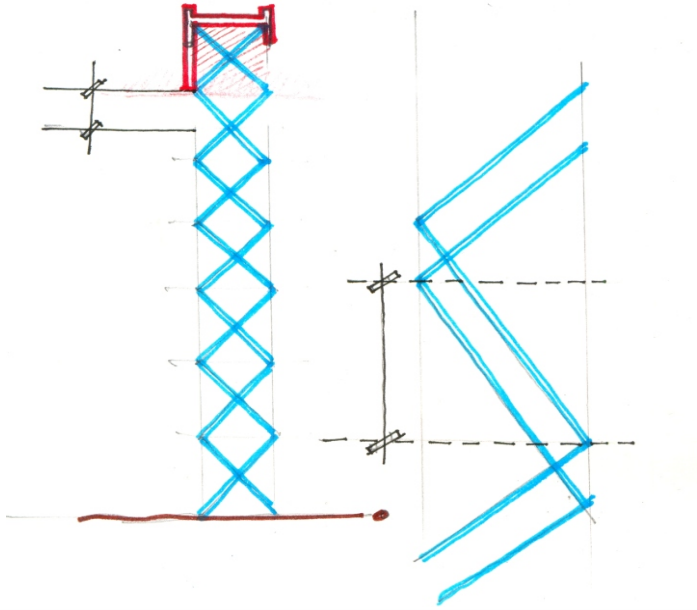


IDEA SKETCH 03

A chain of FRP panels that are connected but is hinged to sway in either direction. It cab locked at a required angle.



IDEA SKETCH 04

The wall is collapsible. The traditional system can be rearranged to increase visibility to sea from shack

6.2 Idea Sketches

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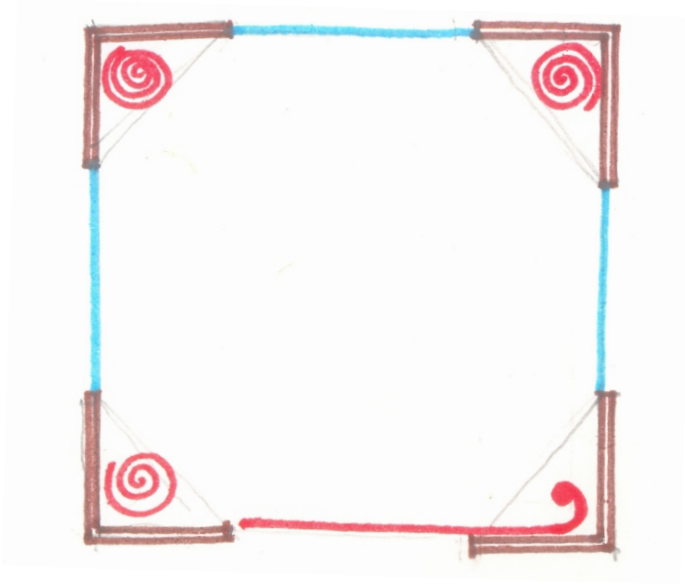
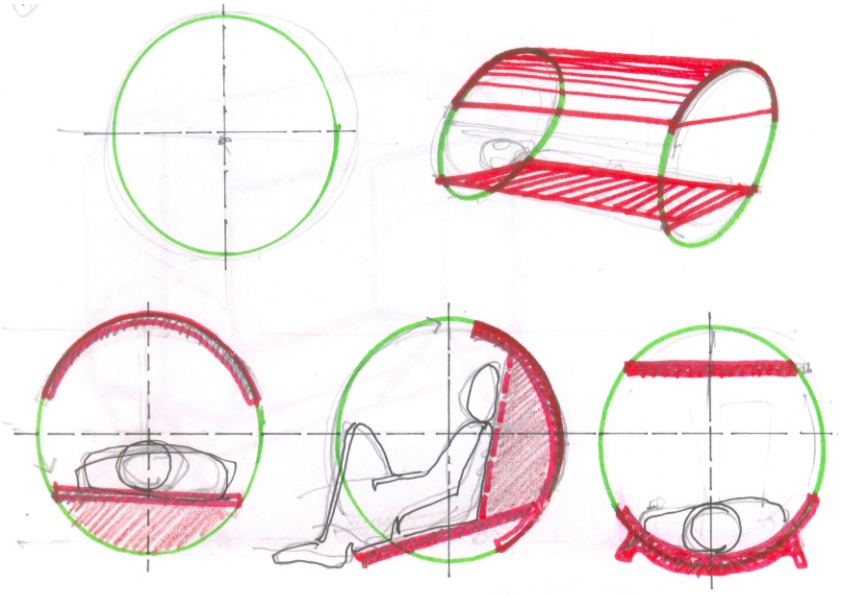


IDEA SKETCH 05

The interiors treated as open space is demarcated using corner pillars which has a retractable wall integrated along with it



IDEA SKETCH 06

Two circular rims held together in tension by fabric and board. Individual members can be rolled around the central axis to take various forms

6.2 Idea Sketches

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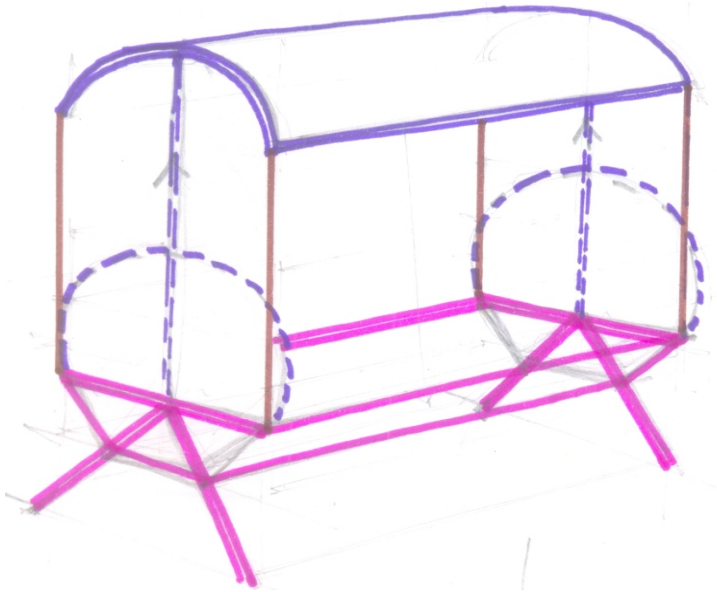
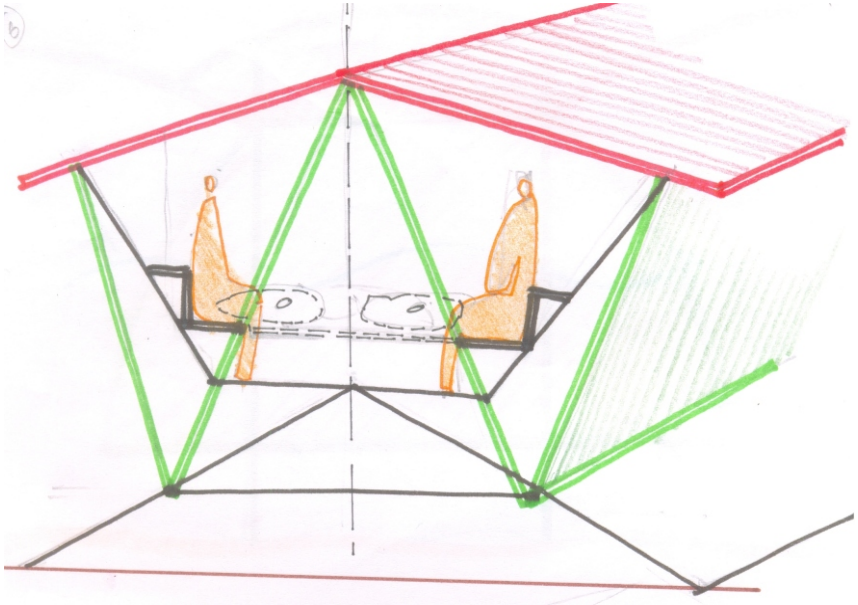
03 Integrating tensile roof along with FRP structure

04 Double storied design solutions



IDEA SKETCH 07

A collapsible roof that can fall into position to be stored away easily. It is an extension of Idea Sketch 06



IDEA SKETCH 08

Collapsible sections that can be folded to a sheet which can be propped on to a vehicle roof and carried to your favourite holiday spot. The bed is detailed to also act as seats as and when required.

6.2 Idea Sketches

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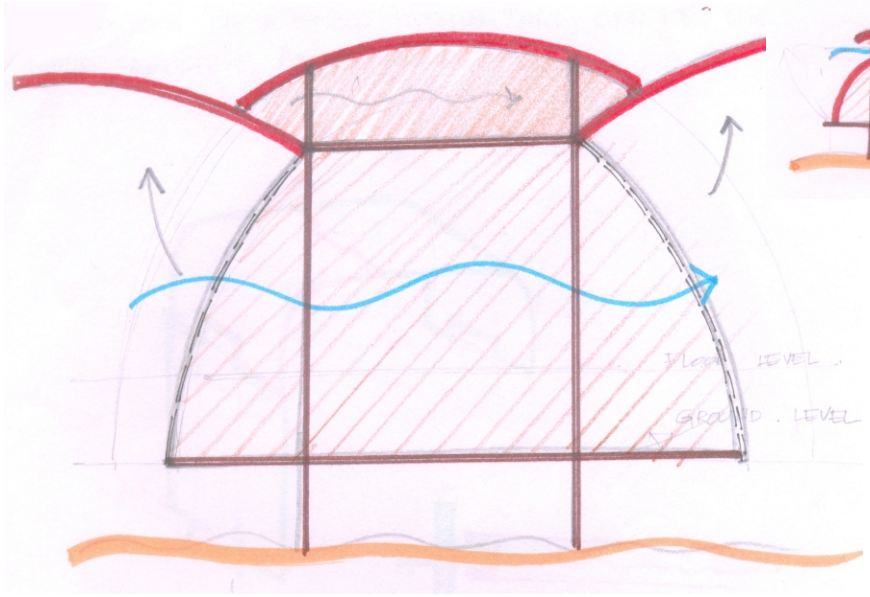
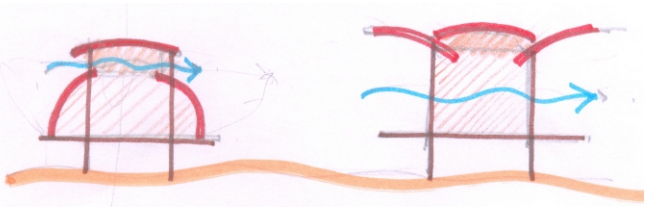
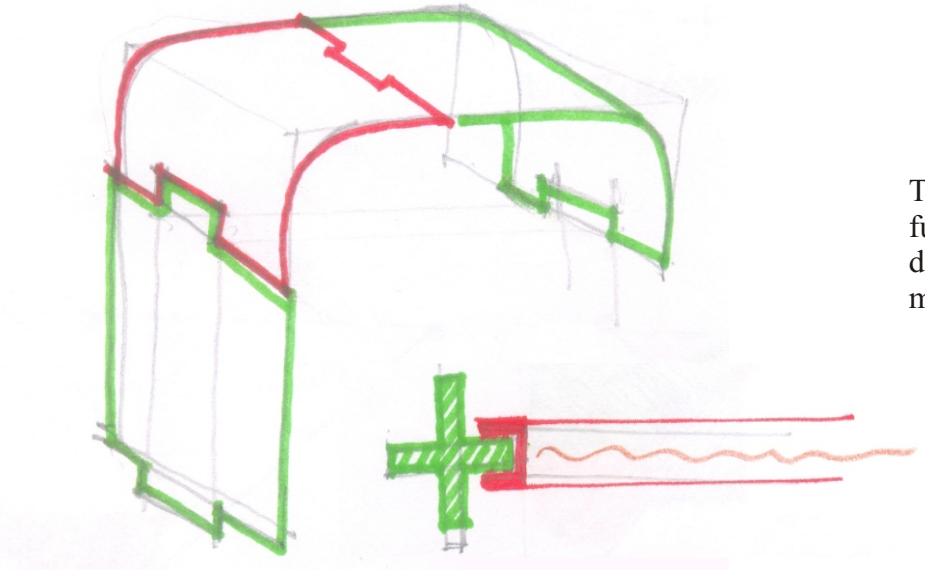




IDEA SKETCH 09

Here the form tries to exploit the sea breeze on the shore to develop an efficient design. There are two states of form when the walls are open and closed. The form give rise two type of ventilation through the hut



IDEA SKETCH 10

The entire structure including the furniture is modular and is developed from a few basic members

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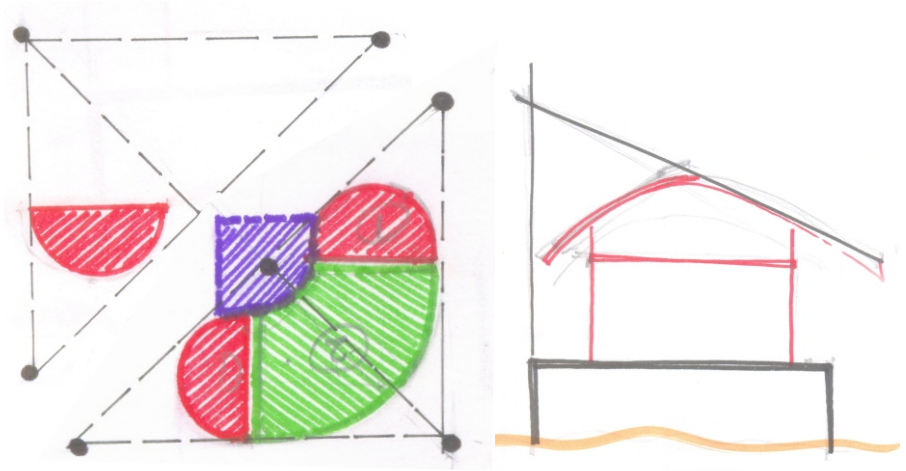
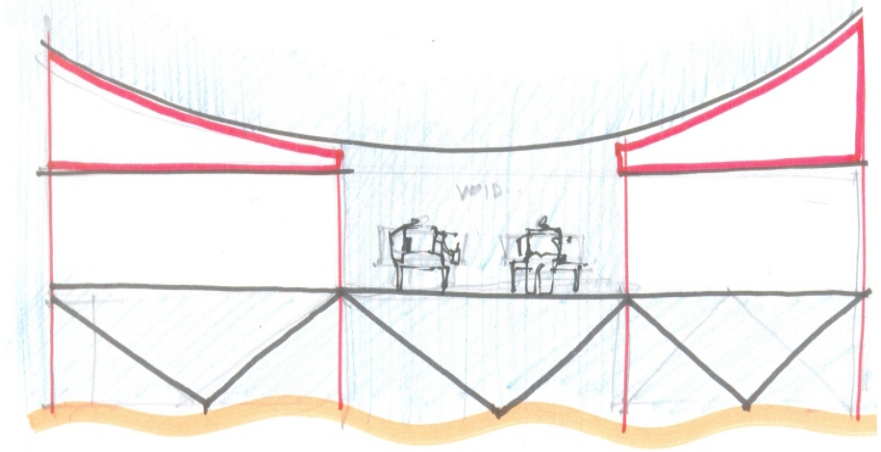
04 Double storied design solutions



IDEA SKETCH 11

Tensile cubicles are joined together. The canvas is pulled to spread on top as a triangle. Similar huts can be places together to develop modules sharing the same roof.



IDEA SKETCH 12

The extension between huts can also be developed as semi-open areas for relaxing. The tensile roof when stretched between huts give rise to such spaces

6.2 Idea Sketches

Initial Idea Sketches were done classified into four major types

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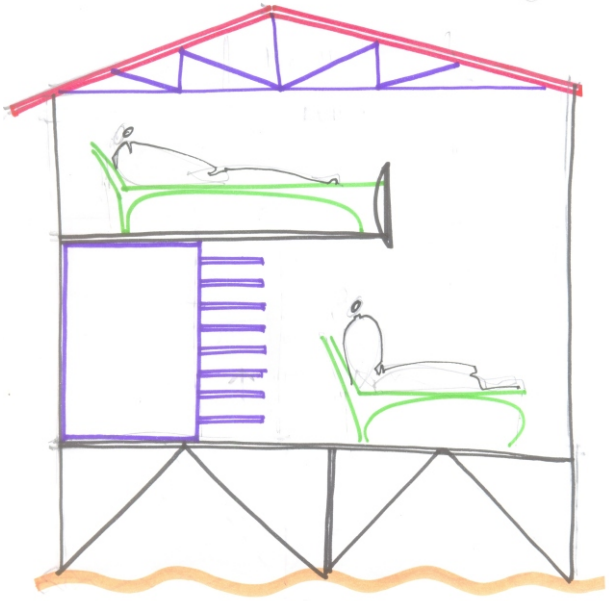
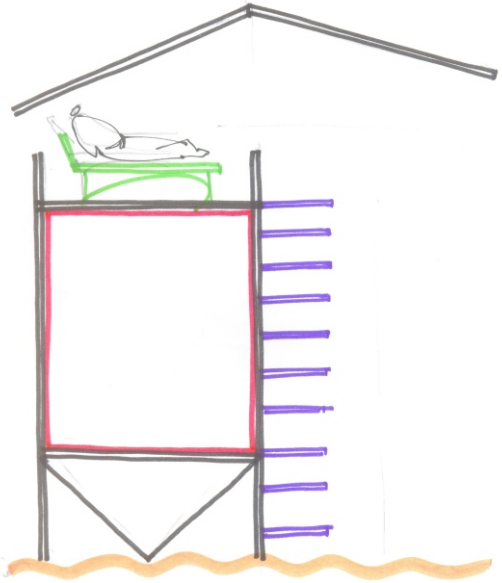
03 Integrating tensile roof along with FRP structure

04 **Double storied design solutions**



IDEA SKETCH 13

Double storied arranegement which allows unhindered view of the sea

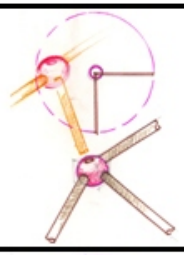
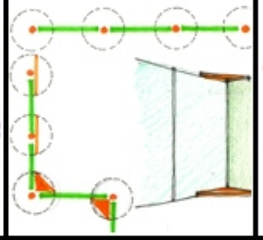
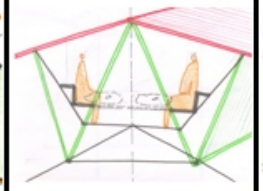
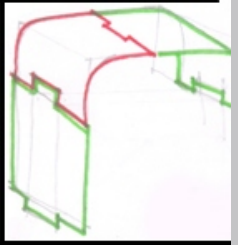
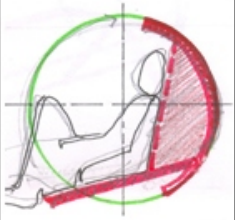
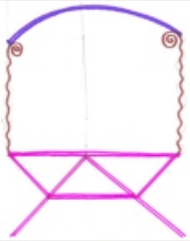
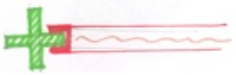
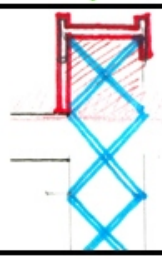
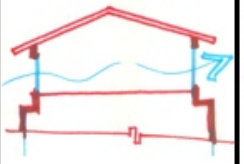
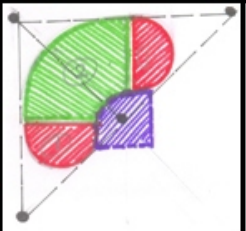
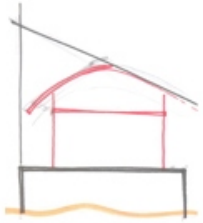
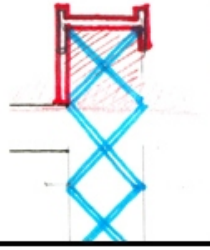
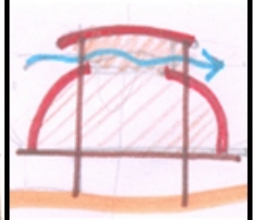
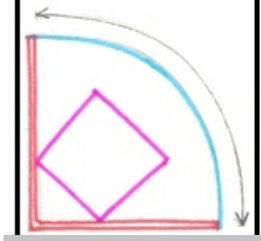


IDEA SKETCH 14

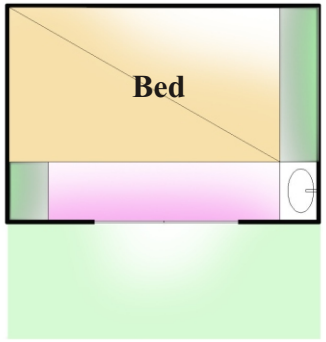
Manipulation of Idea sketch 13 to use minimum plinth area

6.3 Idea Matrix

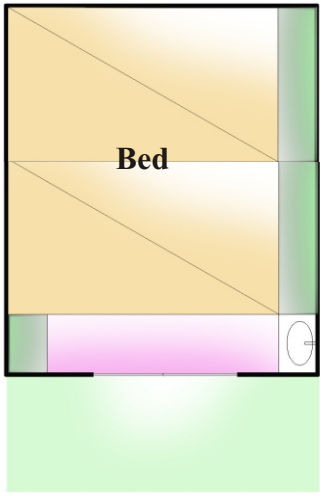
Many of the ideas were done in parts catering to an element or character of the entire structure. They were tabulated to understand how they could be exploited for a complete design

	1	2	3	4	5	6
Frames						
Screen						
Roof						
Walls						
Outdoor Space						

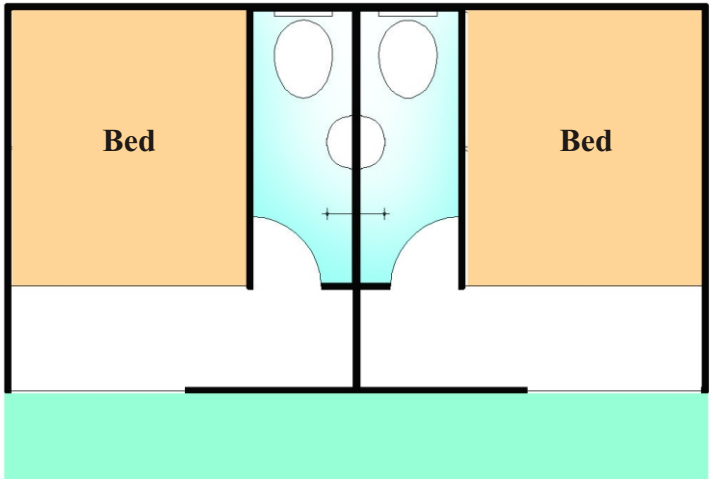
6.4 Interior Layouts



Type I – Single Occupant
240 x 240 mm



Type II – Double Occupant
240 x 360 mm



Two Double Occupant
480 x 720 mm

OPTION 1

The room interiors are arranged such that the **bed is placed parallel** to the sea. In case of a single occupant design the position of bed poses difficulty in viewing the sea.

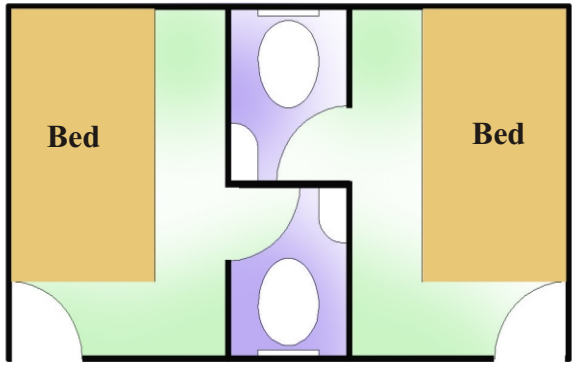
The planning has been done to **minimise the circulation area**

6.4 Interior Layouts

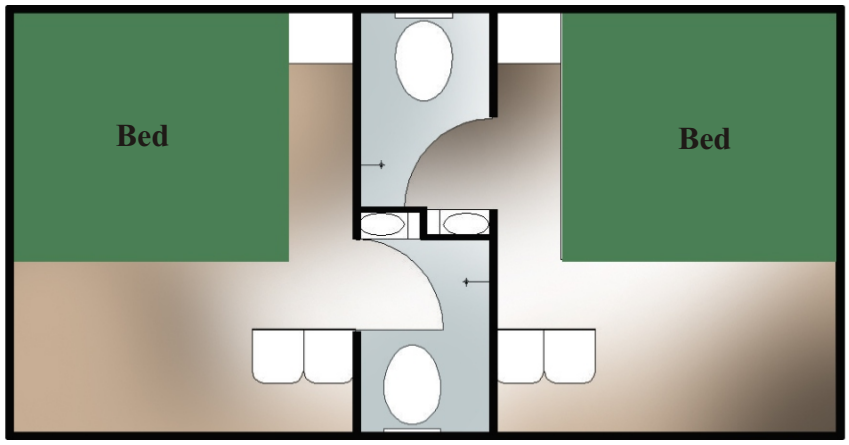
OPTION 2

The room interiors are arranged such that the **bed is placed perpendicular** to the sea. This ensures view to the sea from the interiors of the hut.

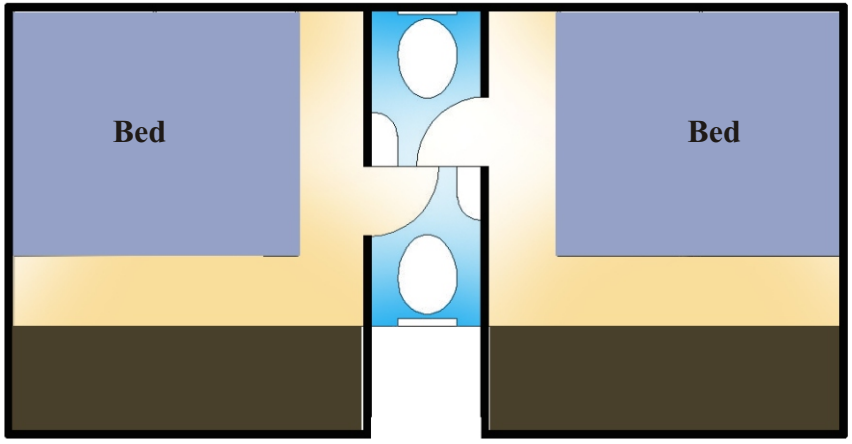
A combination of two huts occupies lesser area



Type I – Single Occupant
480 x 360 mm



Type II – Double Occupant
720 x 360 mm

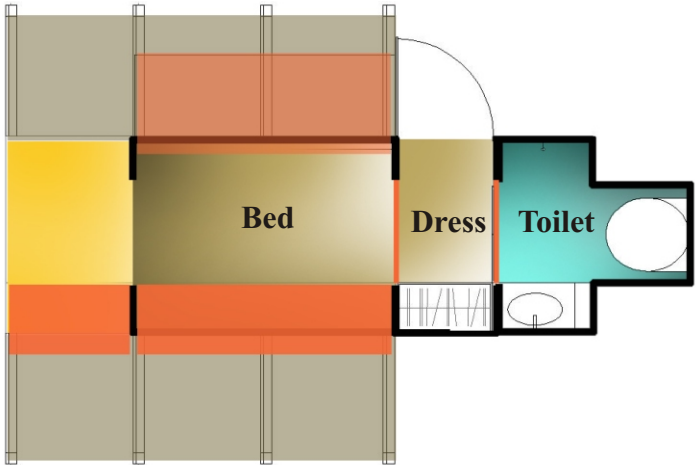


Double Occupant
720 x 360 mm

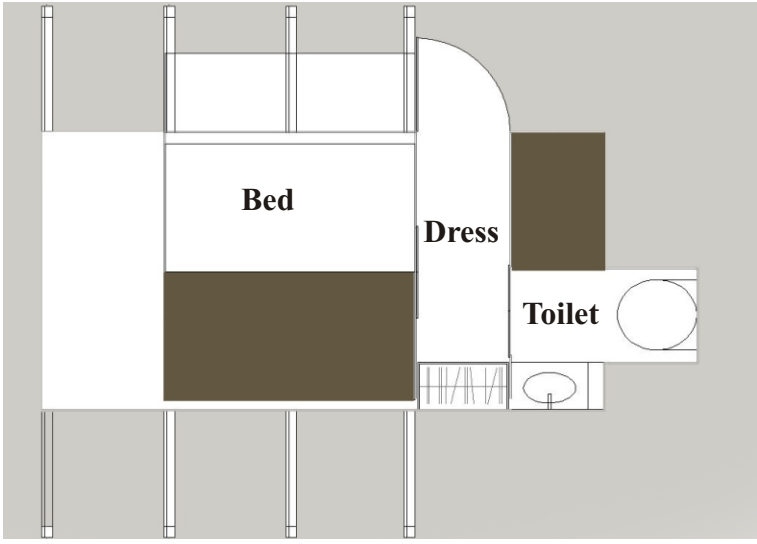
6.4 Interior Layouts

OPTION 3

The toilet is placed behind to gather a linear arrangement. As a result the number of huts that can be placed along the length of the shack increases



Type I – Single Occupant
120 x 420 mm



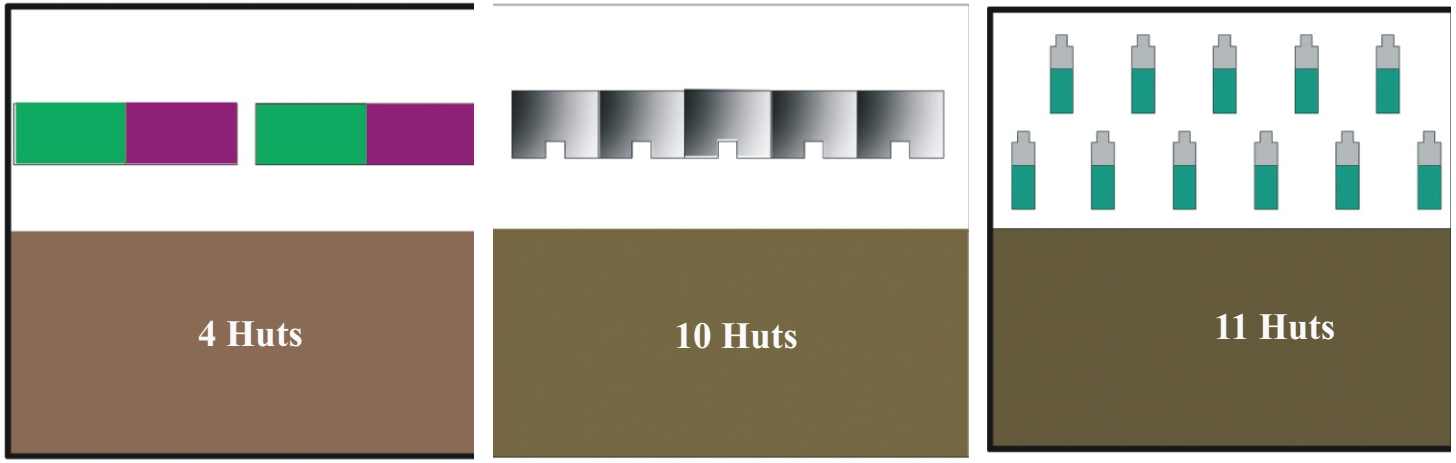
Type II –Double Occupant
240 x 420 mm

6.5 Layout within a shack

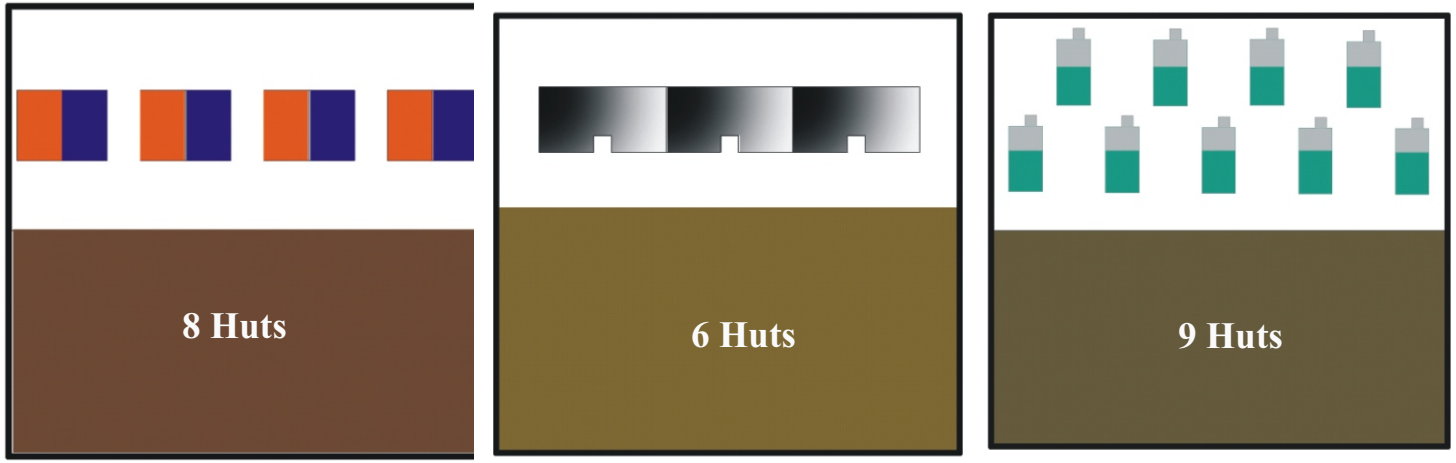
The layout within shack was done to understand which option permitted the maximum number of huts

A single shack area being 24 m x 24m

Type I – Single Occupant



Type II –Double Occupant



OPTION 1 **OPTION 2** **OPTION 3**

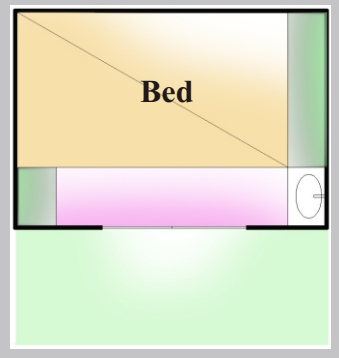
6.6 Concept development

Has an overall rustic appearance

Panels were of two types either plain or a frame.

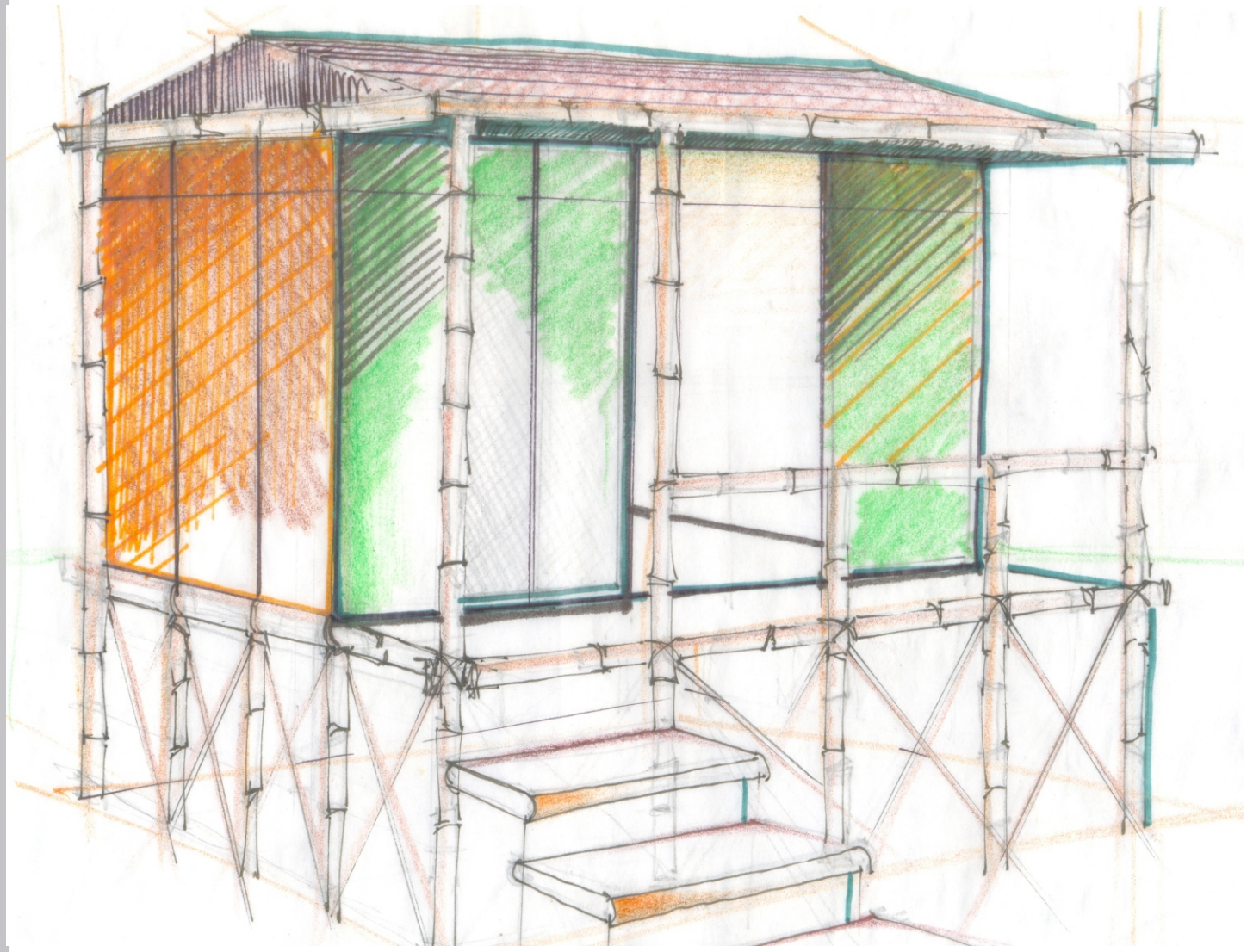
Module size was maintained to plan option -1

Range of allowances to be thought of when using a natural and manufactured project had to be thought of



Type I – Single Occupant
240 x 240 mm

Concept 01



6.6 Concept development

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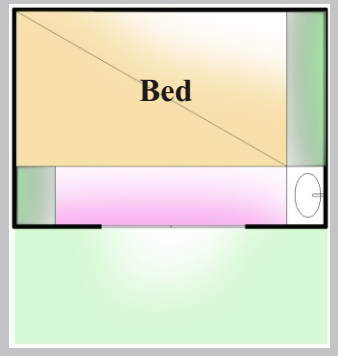
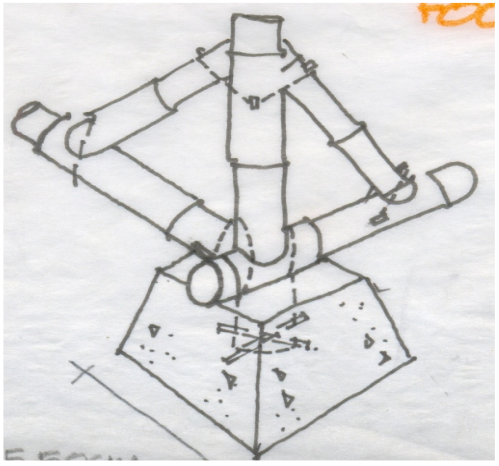
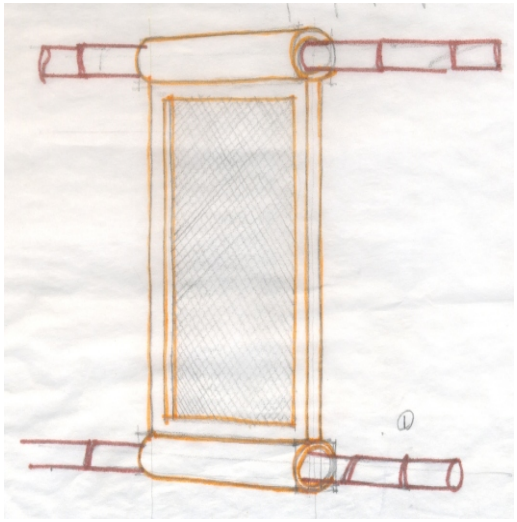


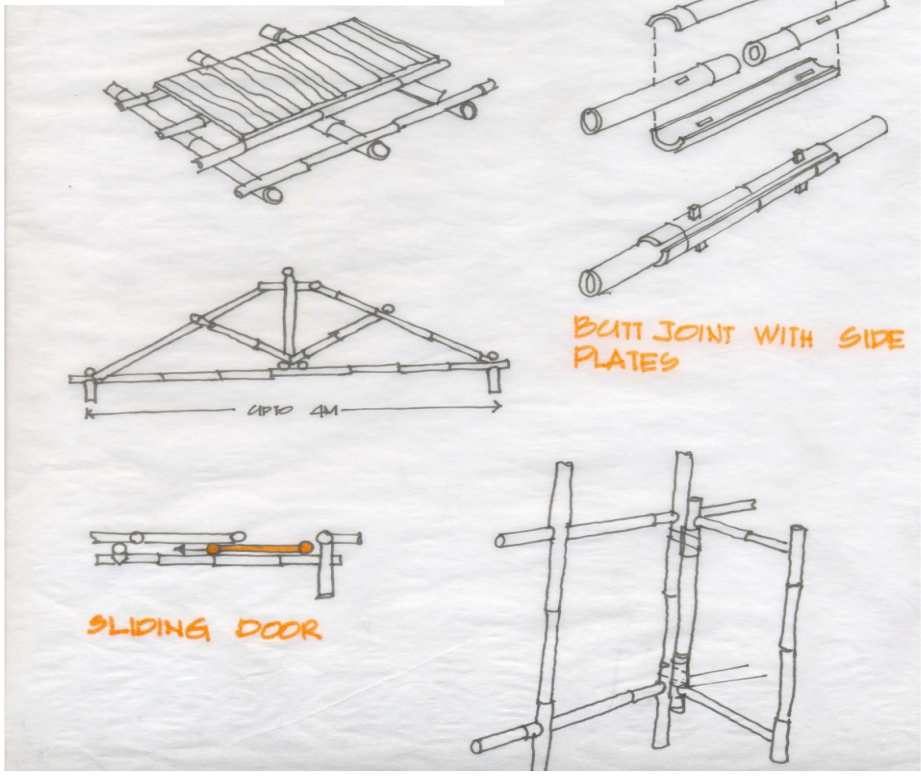
Type I – Single Occupant
240 x 240 mm

Concept 01





Design details were visualized through sketches to understand how the design could be implemented



6.6 Concept development

A mobile home that can be carried and mounted anywhere on the beach

A triangular prism module in FRP

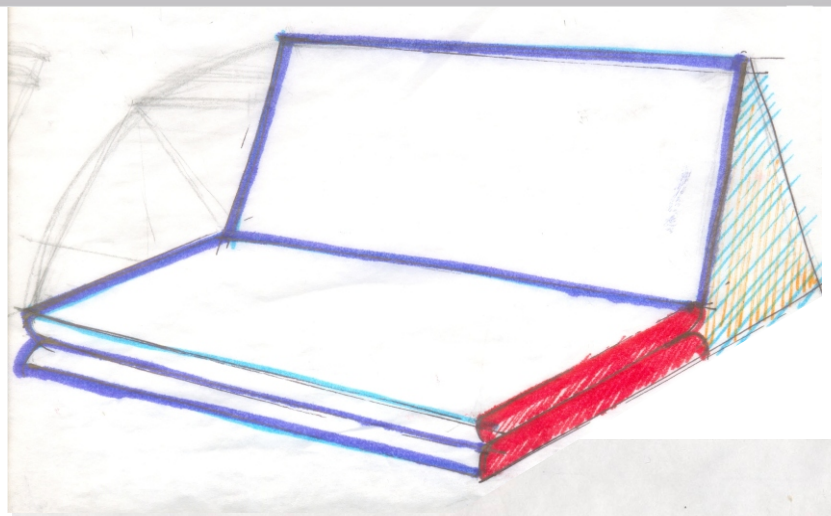
It acts as a storage for personal belongings and also as a backrest when the individual is sits

The entire structure is collapsible

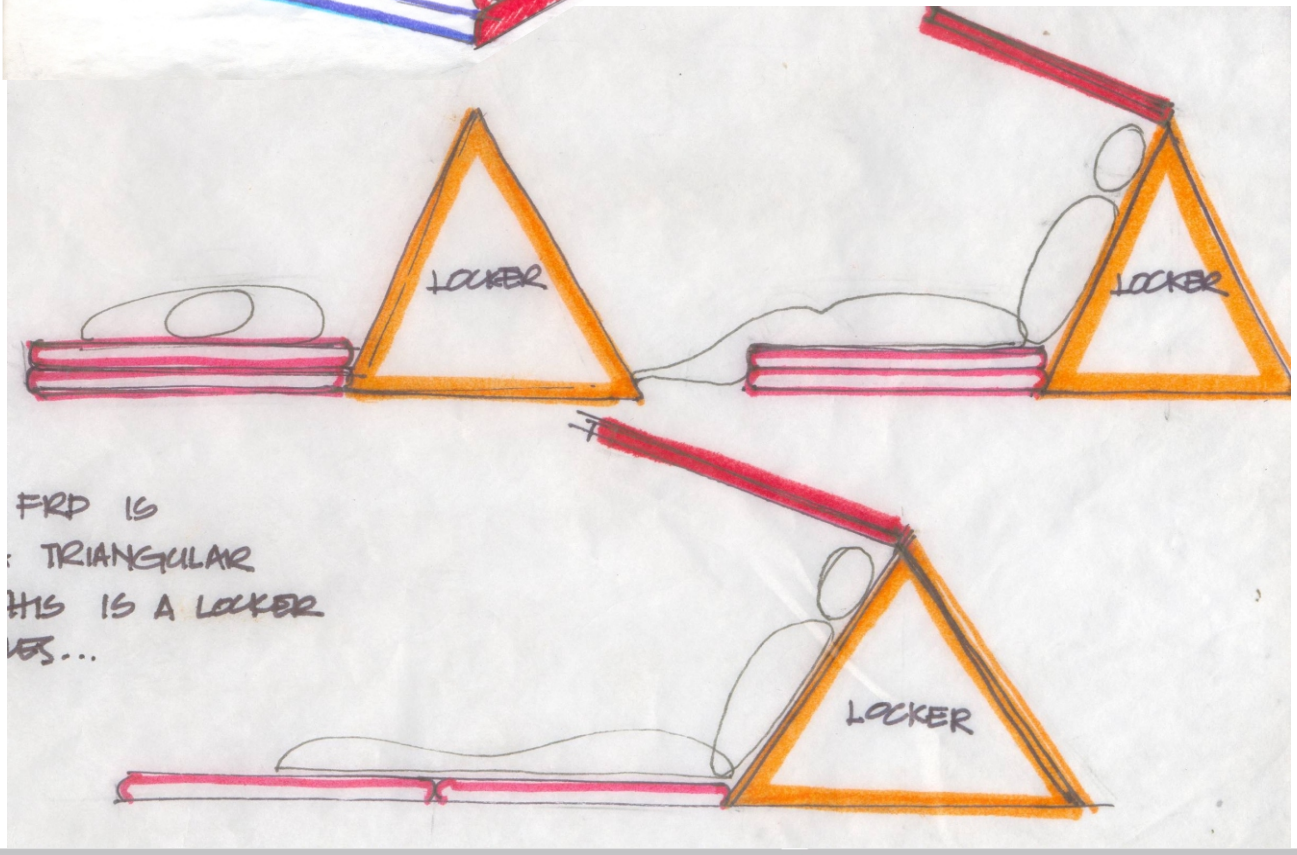
The solution doesn't include a toilet

There is absence of privacy

The structure as a hole can be stolen when the user is not around



Concept 02 - a

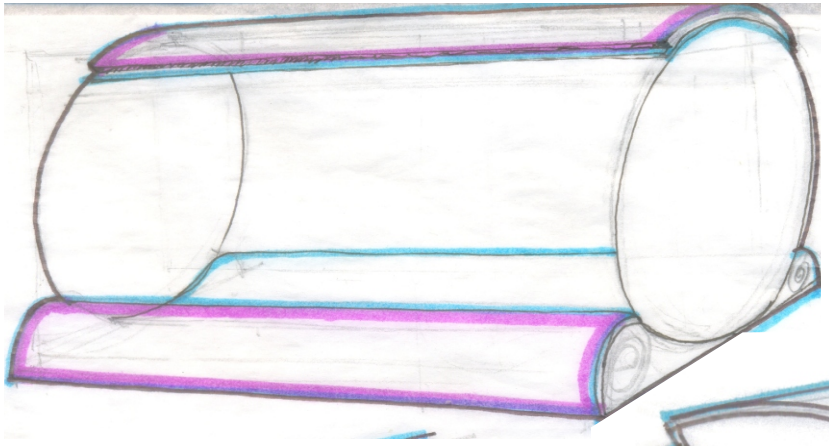


6.6 Concept development

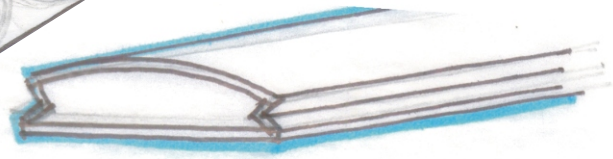
A mobile home that can be carried and mounted anywhere on the beach

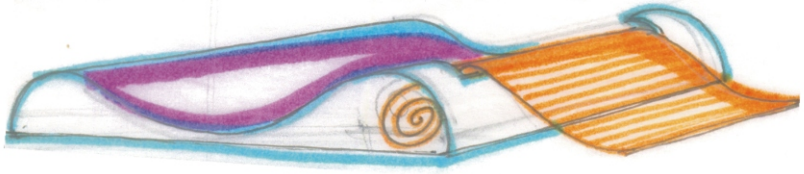
The structure as a whole may be stolen when the user is not around

Absence of a secure storage system



Concept 02 - b

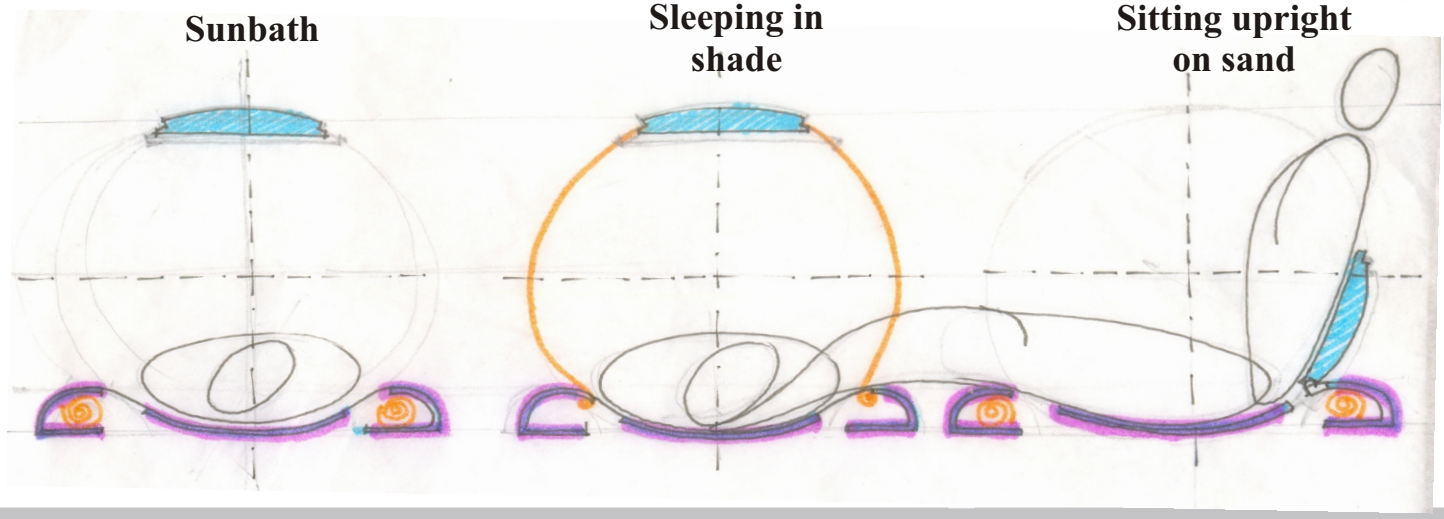




Sunbath

Sleeping in shade

Sitting upright on sand



6.6 Concept development

A cabin in FRP

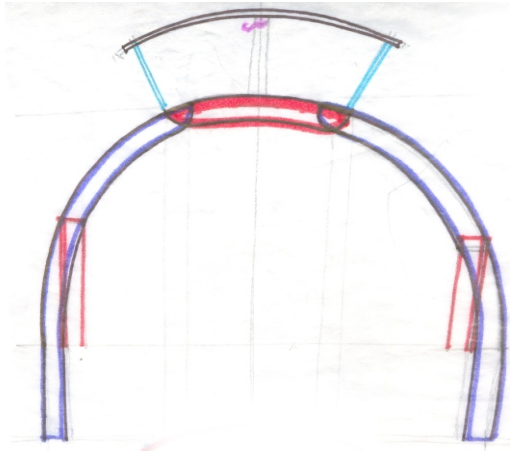
Form has been developed from the basic understanding that these structures require two kinds of ventilation at different times of the day

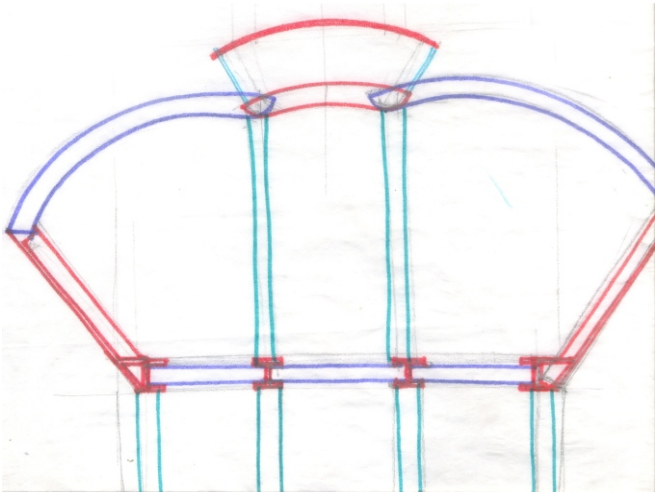
A continuous curved frp panel with flanges @120mm which add to its strength

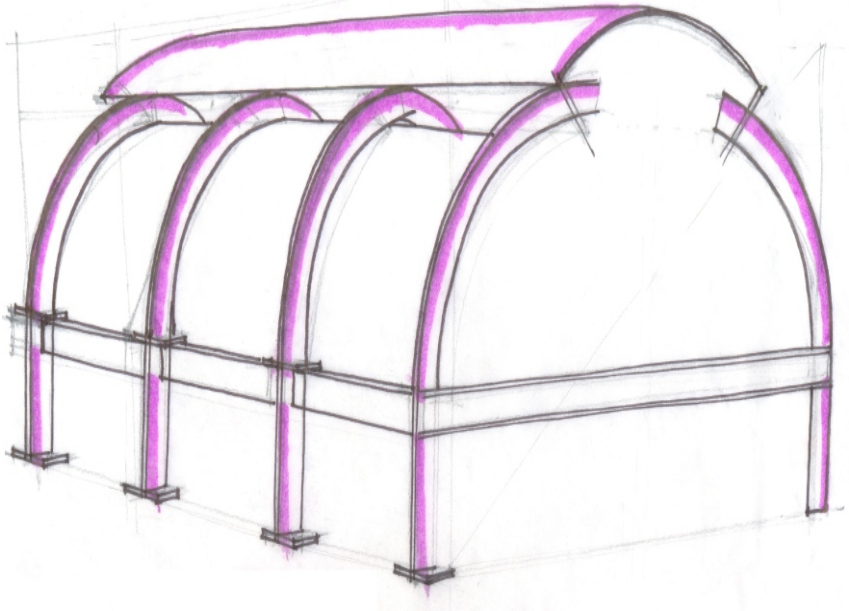
Manufactured get a textured finish on the outside

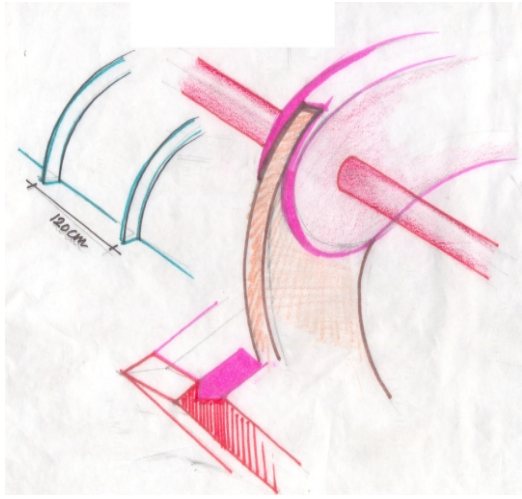
Has poor head room above the bed when completely closed

Concept 03 - a







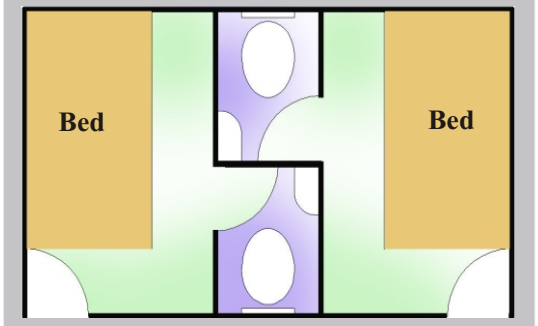


6.6 Concept development

A cabin in FRP

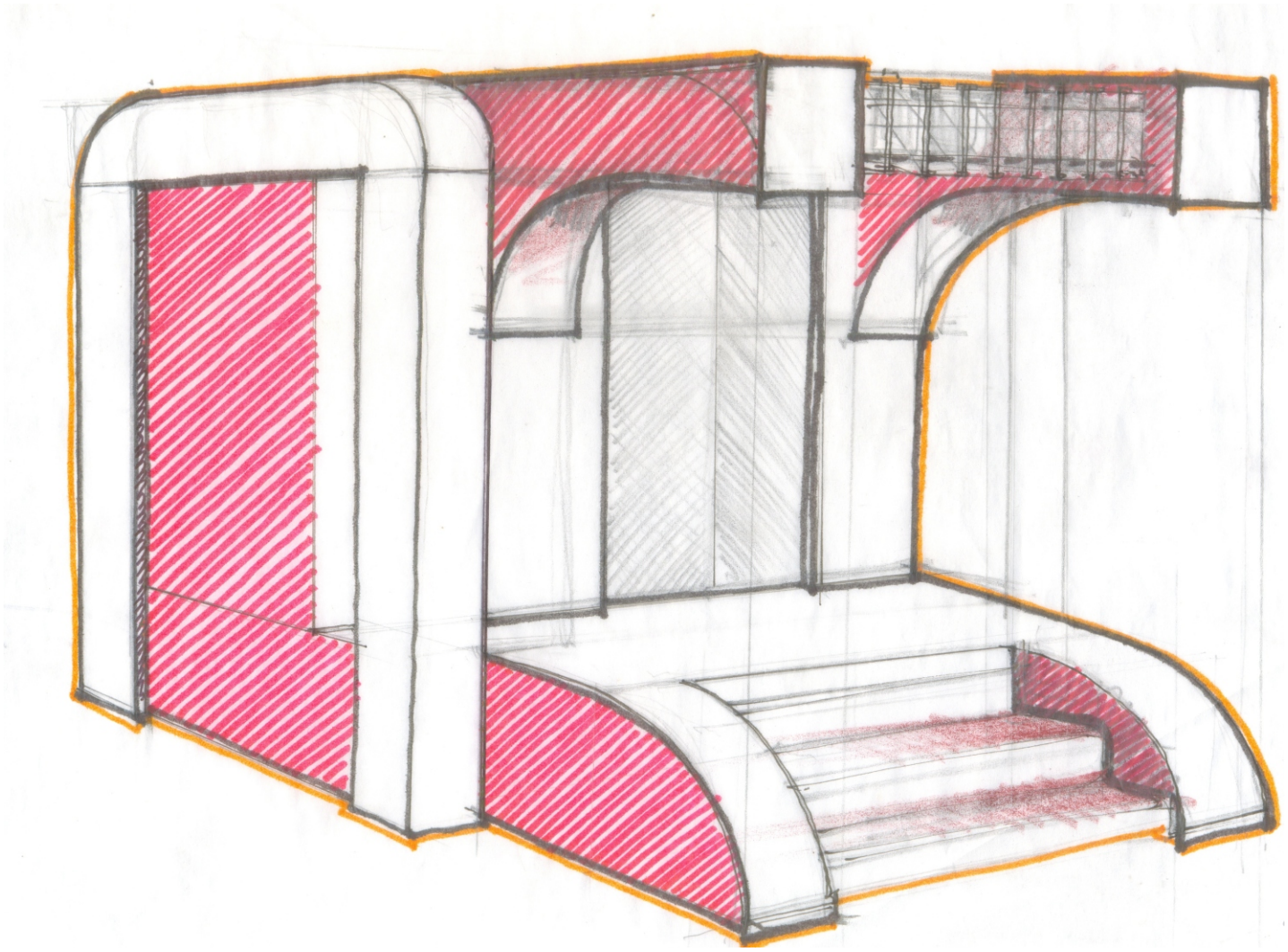
Attempt to play with form to suit the same concept where poltruded FRP sections were used to develop pergolas for verandah and support for roof and foundation

Poltrusion of FRP panels is very expensive



Type I – Single Occupant
480 x 360 cm

Concept 03 - b



6.6 Concept development

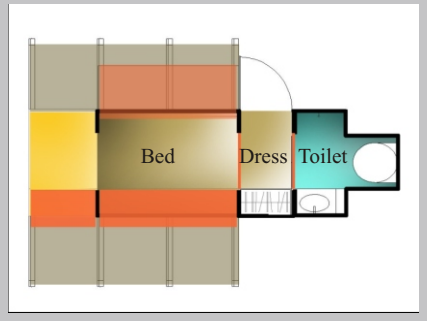
Frames of FRP for living area where skin is completely retractable

The concept tries to cater to the emotional requirements of tourists

Everyone wants a space of their own to lie down and watch the sea

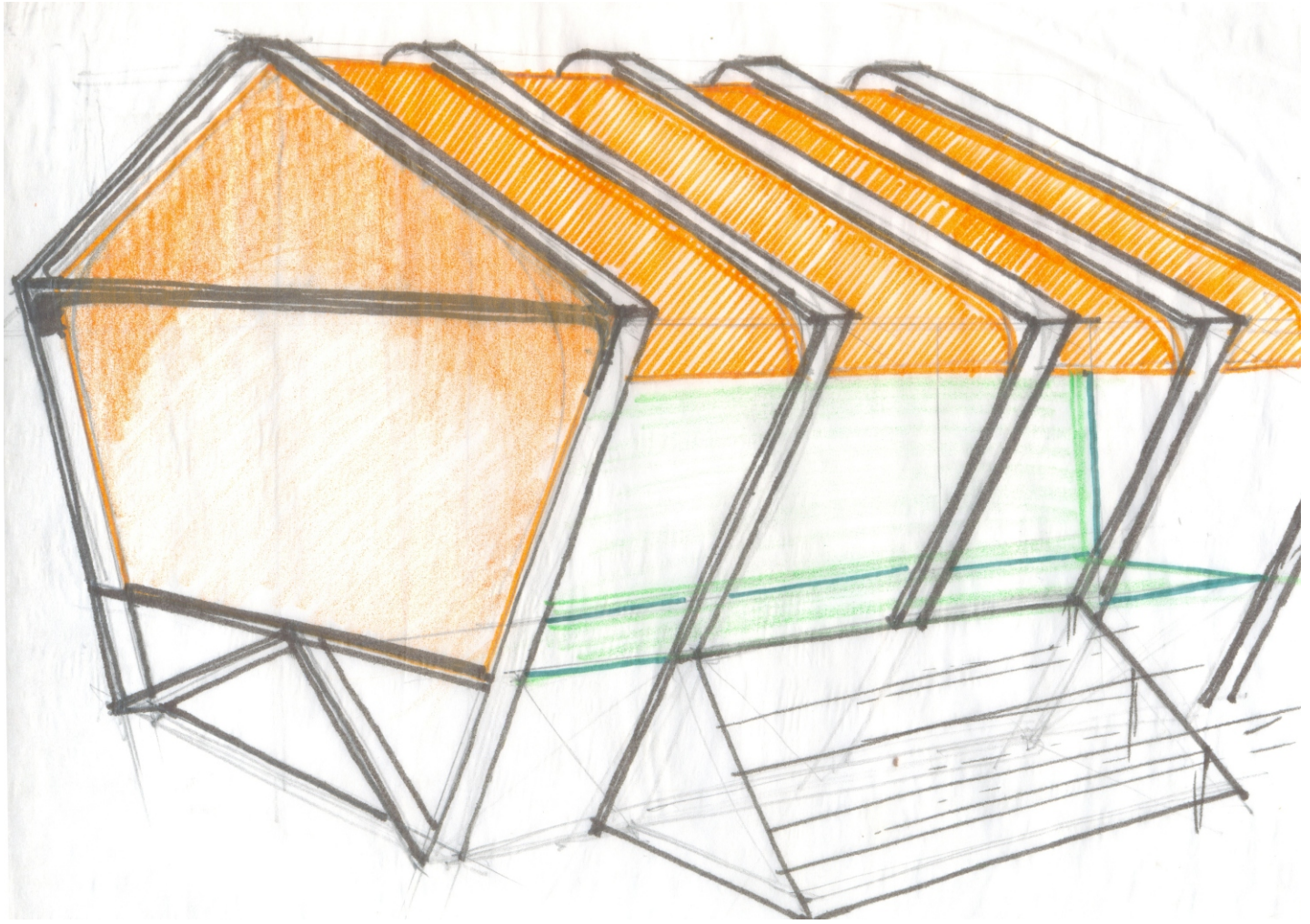
the sky as viewed form lying on their back was important
the structure allows sea breeze through it

The secured area is separately treated with care and is taken to the rear of the cabin

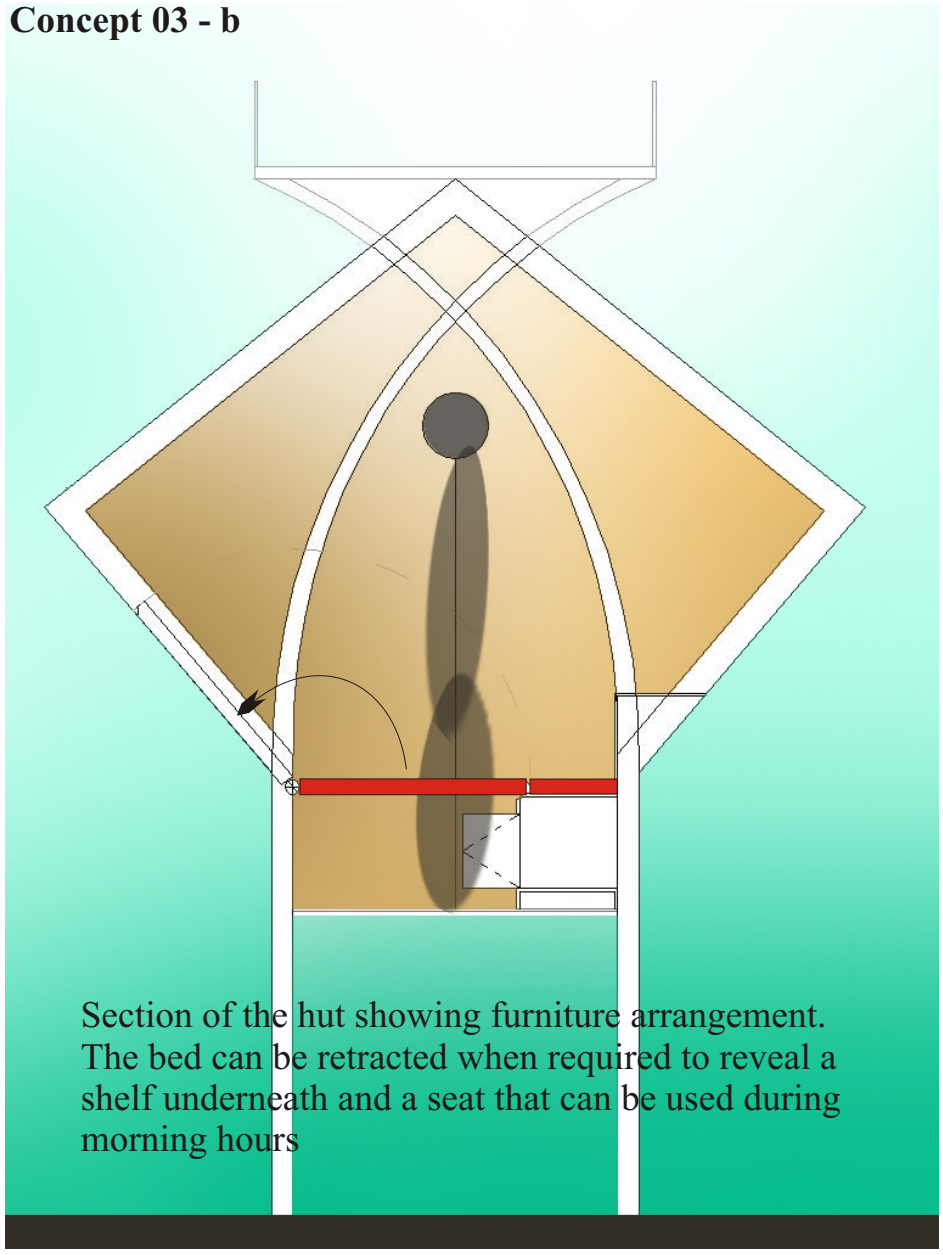


Type I – Single Occupant
120 x 420 cm

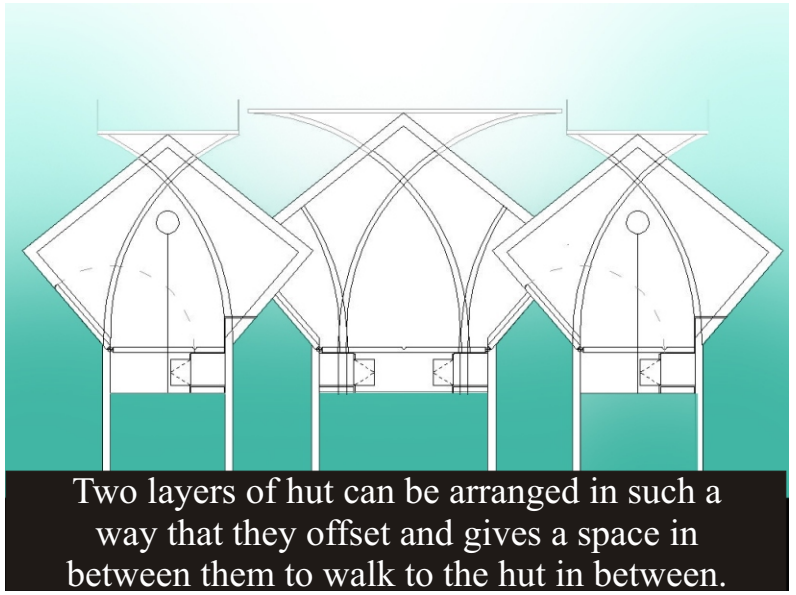
Concept 03 - b



Concept 03 - b

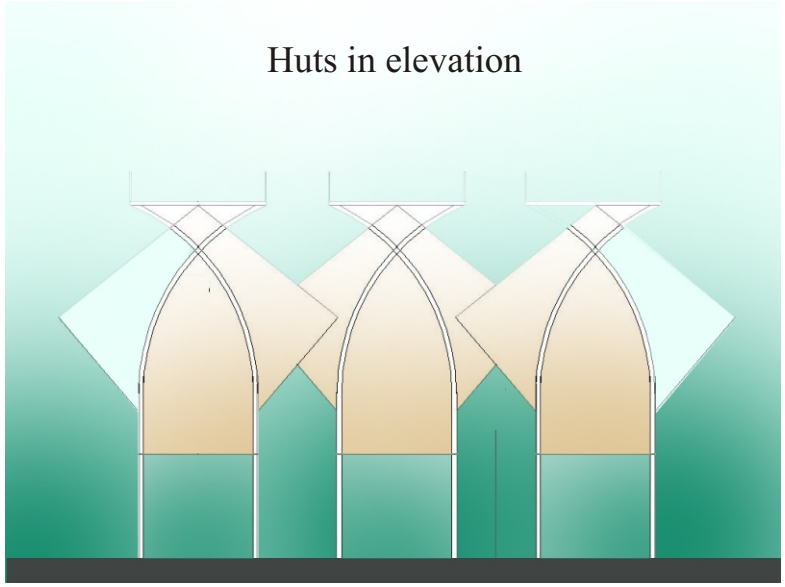


Section of the hut showing furniture arrangement. The bed can be retracted when required to reveal a shelf underneath and a seat that can be used during morning hours



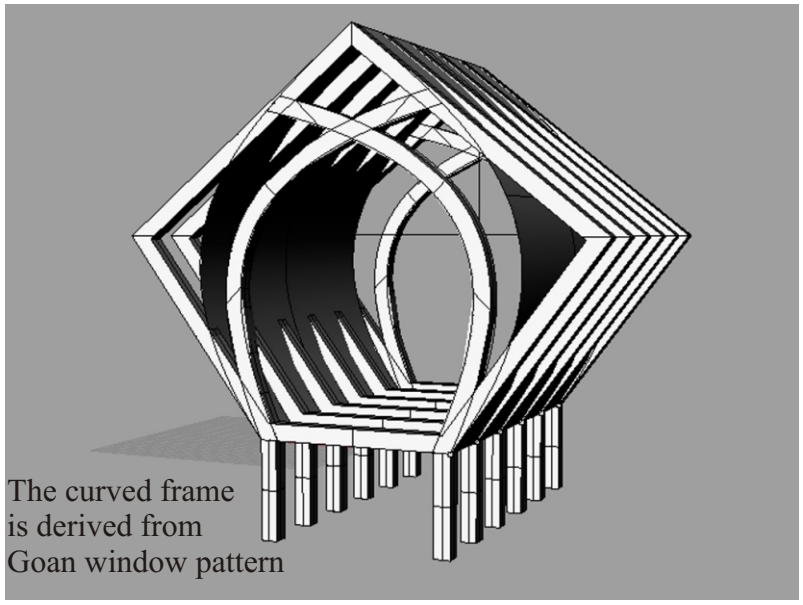
Two layers of hut can be arranged in such a way that they offset and gives a space in between them to walk to the hut in between.

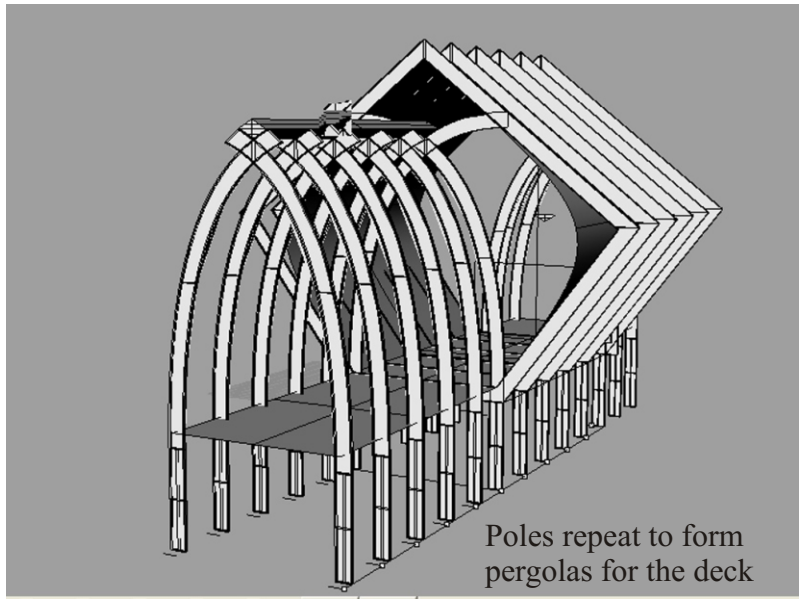
Huts in elevation

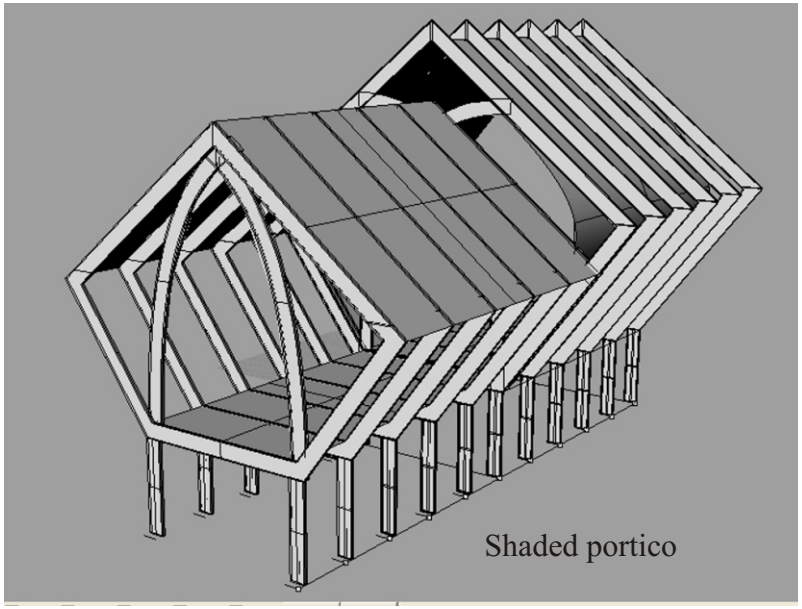


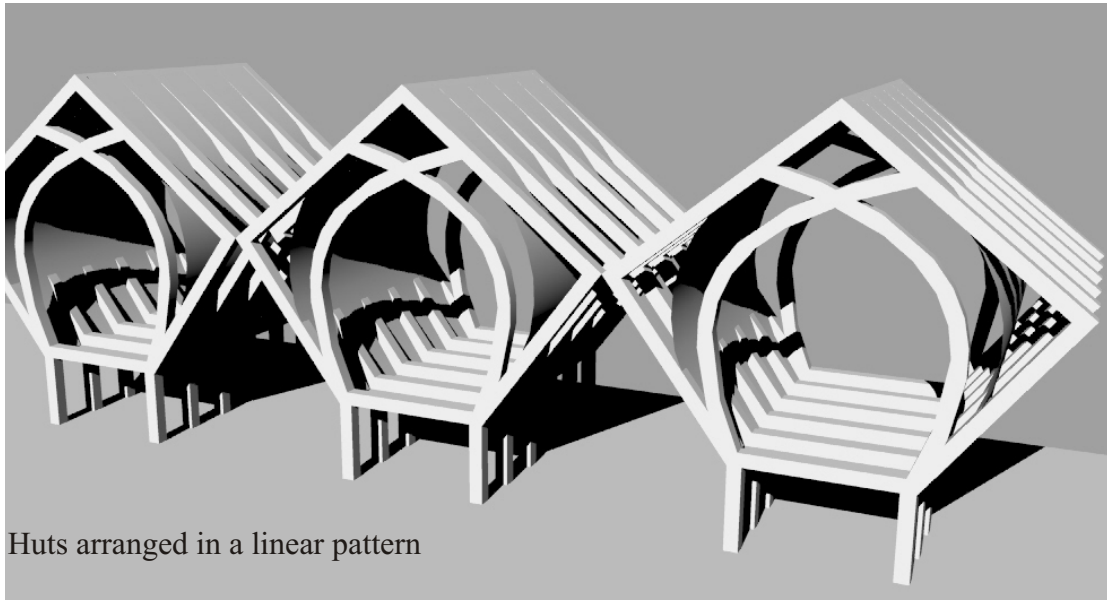
Concept 03 - b

Form Exploration



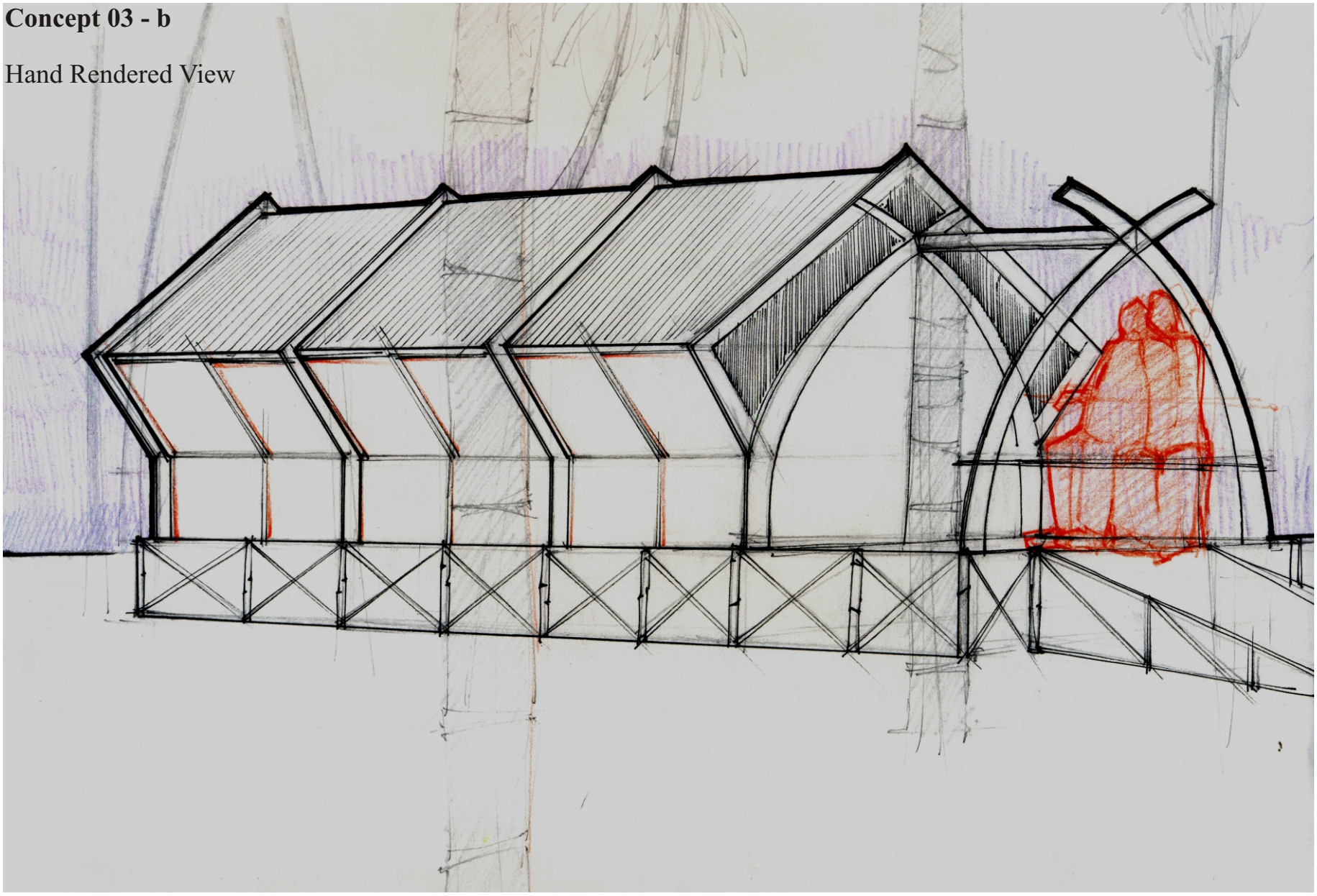




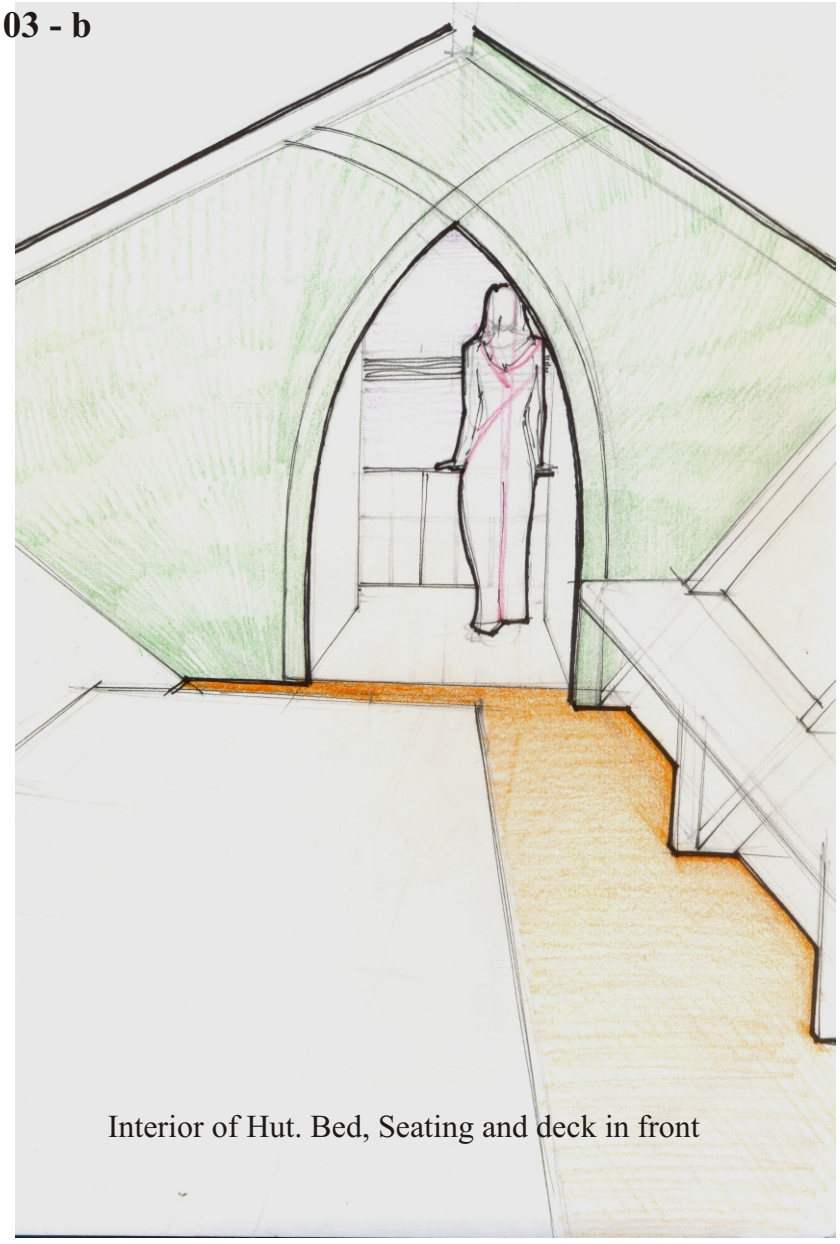


Concept 03 - b

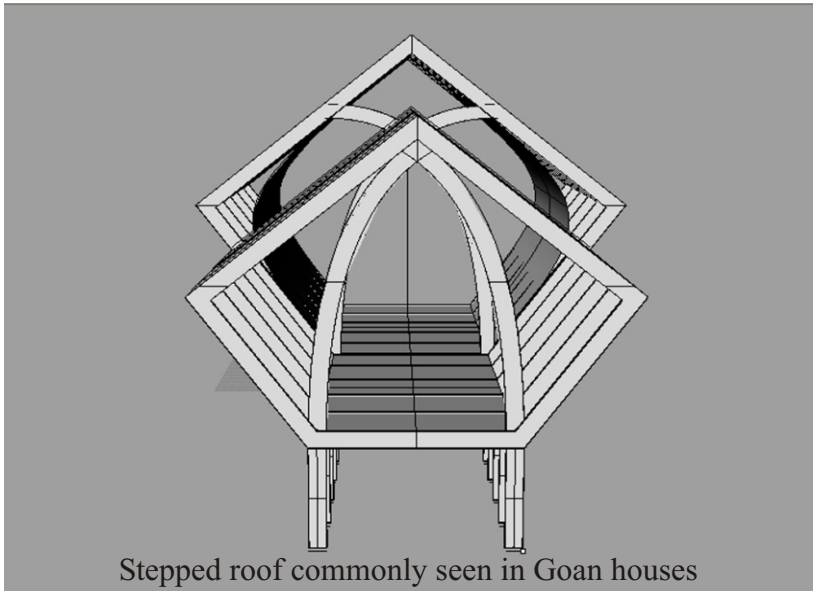
Hand Rendered View



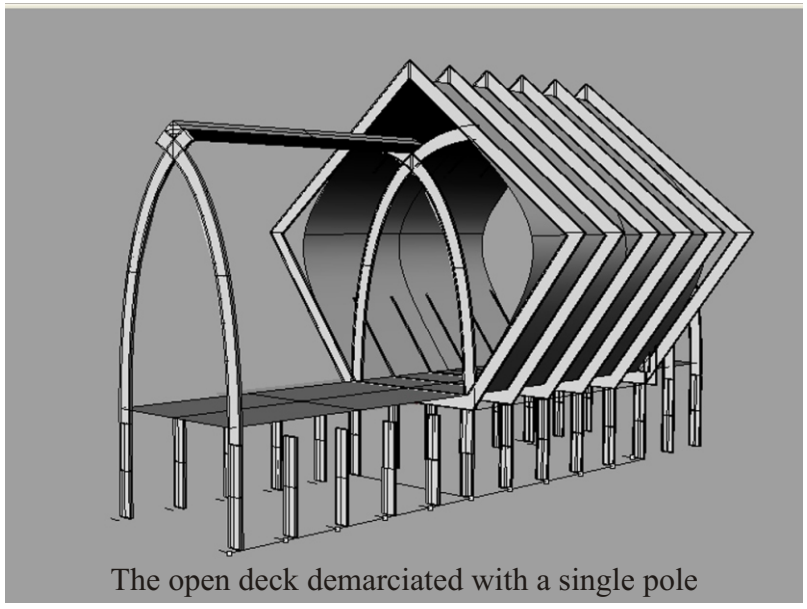
Concept 03 - b



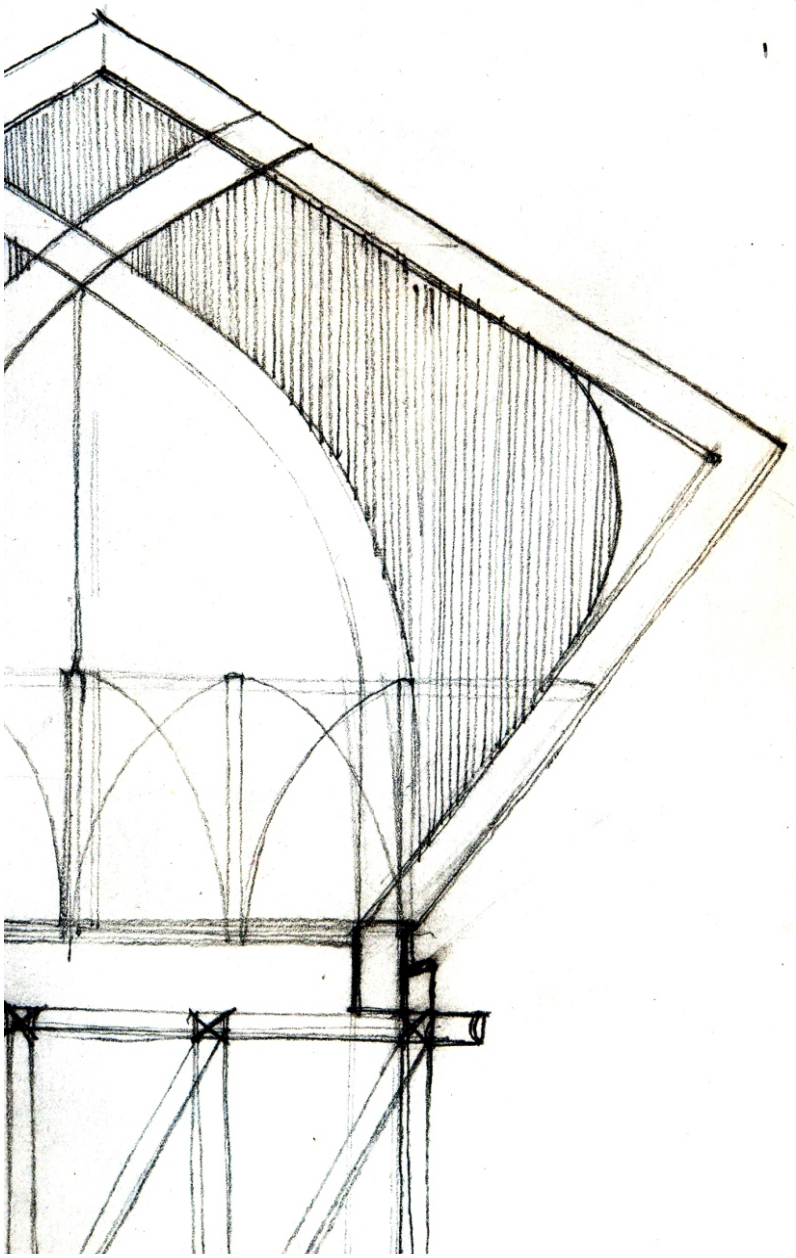
Interior of Hut. Bed, Seating and deck in front



Stepped roof commonly seen in Goan houses



The open deck demarciated with a single pole



Concept 03 - b

The form tried to show justice to understanding the bicultural identity that these structures carry

The treatment of frames is typical of Goan houses. The sloping roofs of traditional houses as well as huts is slightly modifies to integrate with the structure and form to give it an identity of its own.

Each hut has a stilt type of construction in bamboo and the assembled FRP structure is placed on top of it

The curtain wall panels is two layered, an outer insect screen which acts as a mosquito net and inner layre of teflon coated fiber glass membrane which can retracted and rolled up like a curtain

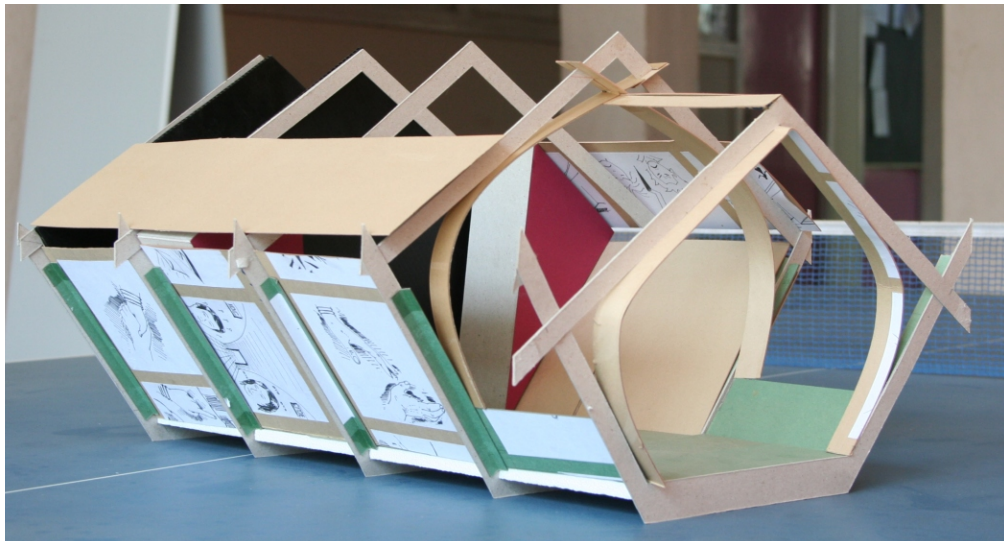
Careful planning has been done to improve space and also the concept of a deck above the shack height which can be a personal space for sunbath is provided.

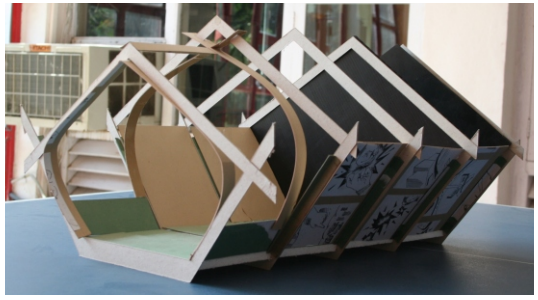
The ladder for this is given outside so that the shack boys can serve food upstairs with entering the house

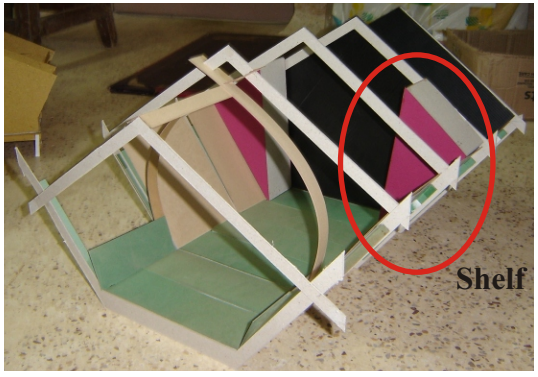
The design undergoes most efficient way of exploiting the sea frontage provided to the beach shack owners

FINAL CONCEPT

7.1 Exploratory Model







Exploratory Models were made to better understand various elements of each module. The method of assembly, of the entire structure was also analyzed. Each element (wall, frame, opening and floor) was made as a separate entity and were fitted together to stand in place. This helped to understand the design better and gave way to further refinement

Concept 01 and Concept 03-b were condensed to form a holistic design.

Figures show aerial view of hut.

The **frame** is made of bamboo and FRP panels slide through them

The hut is made up of **three modules** . The floor of which can be extended to form the deck.

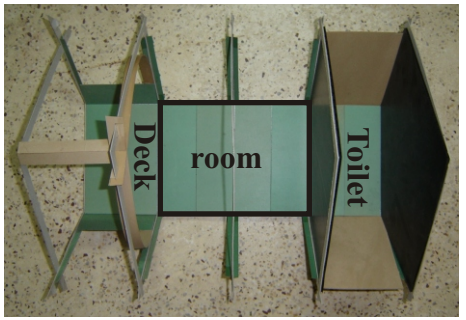
The **bed** is placed towards one corner of the room and the **toilet** module to the rear.

The **angular space** with in the room increases the perception of space with in, though the floor area is kept to the minimum.

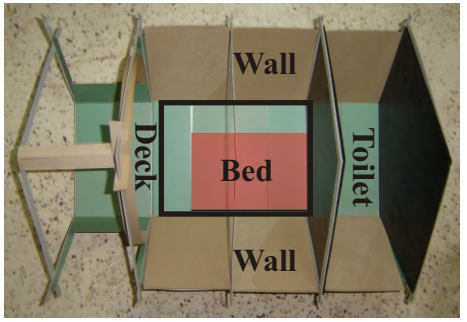
This angular space is used for **shelves** and does not eat into the room space

The **deck** in front. of the hut is at a lower height and Gives way for stepped roof

01



02



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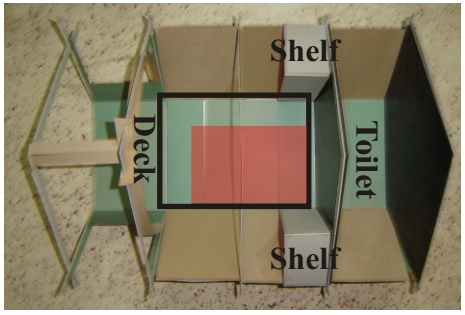
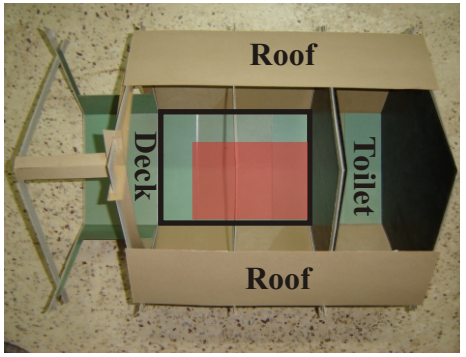


04



7.2 Design

The design attempts to identify and correct flaws in planning, circulation, assembly and manufacturing in the concept as learnt from the exploratory model

Foundation

View from front

7.2.1 Foundation

A bamboo stilt construction is adopted for the foundation. At present the coco-huts are put up by traditional craftsmen. The design is done keeping in mind that the same workmen would assembly the hut. A foundation in bamboo would be comparatively cost effective and efficient.

7.2.2 No. of occupant

The design caters to modify itself into two types. One for an individual resident and the second for a couple. The entire hut is divided into modules of 300 x 150cm.
Type I for single occupancy comprises of 2 modules and
Type II for double occupancy has 3 modules

7.2.3 Bed

The room is primarily occupied by a bed the size of which varies for both types. The floor of the module itself curves, bends and bolts in place to act like a bed. There is no need for additional furniture in the hut.

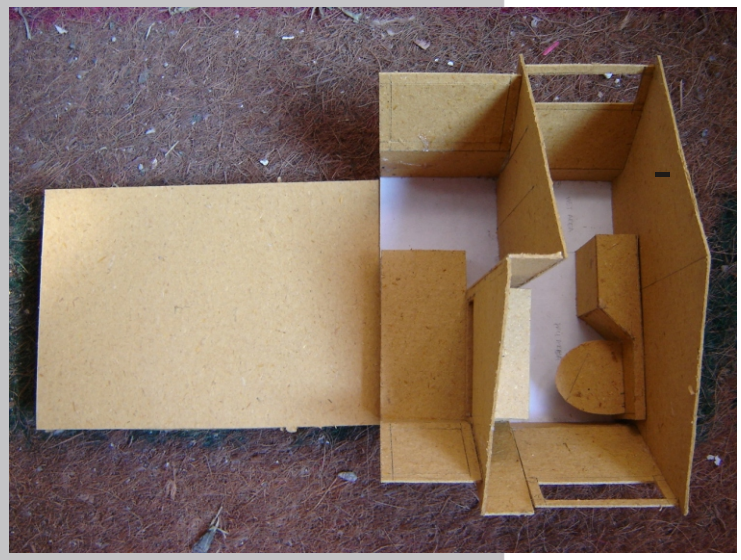
7.2.4 Storage

Much care has been taken to provide ample space for storage. The security of personal belongings of tourists was given primary importance.

7.2.5 View

The view to sea from within the hut is made possible by means of a fairly large opening on the front facade. The semi closed verandah of the hut acts as the prime place for relaxing and watching the sea

7.3 Circulation & Planning



Type I - Single Occupancy

Type I

Single Occupancy

Built area - 3.0m x 3.0m
Modules - 2 No.s
Unbuilt area - Verandah

Type II - Double Occupancy

Type I

Double Occupancy

Built area - 3.0m x 4.5m
Modules - 3 No.s
Unbuilt area - Verandah

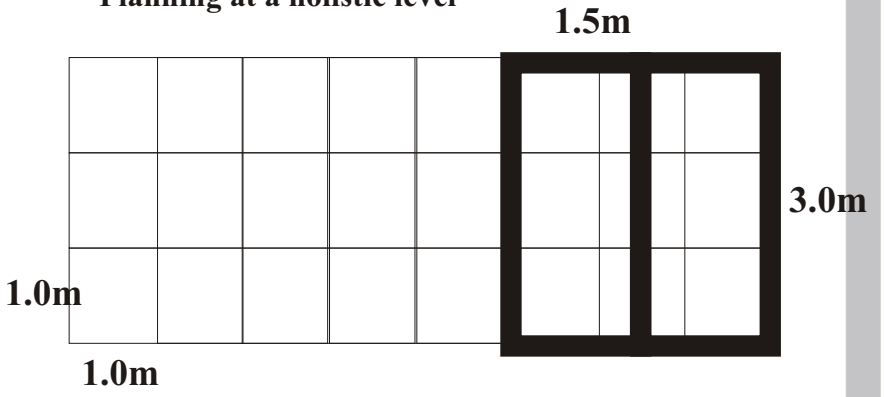
7.3.1 Modular Grid

A grid of 1.0m x 1.0m has been used for the design. This grid could accommodates most of the furniture and circulation space required at a holistic level in a comfortable manner.

Each module is of 1.5 x 3.0m.

7.3.2 Planning

Planning at a holistic level



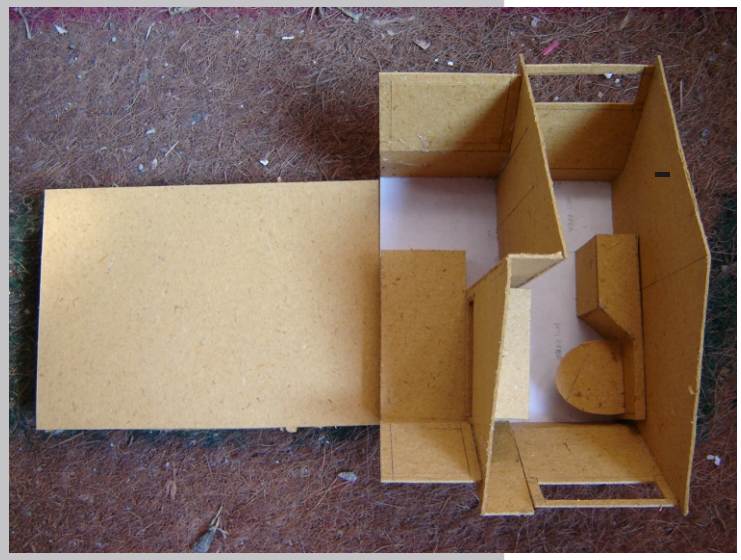
Grid - 1 x 1m
Module size - 3.0 x 1.5m

7.3.3 Modules

Toilet Module - This is common for both type of huts. A spacious and effective layout is chosen here.

Room module - The room module is again common for both type. For Type II, double occupancy a mirror image of the room module is used to complete the design

7.3 Circulation & Planning



Type I - Single Occupancy

Type I

Single Occupancy

Built area - 3.0 x 3.0m
Modules - 2 No.s
Unbuilt area - Verandah

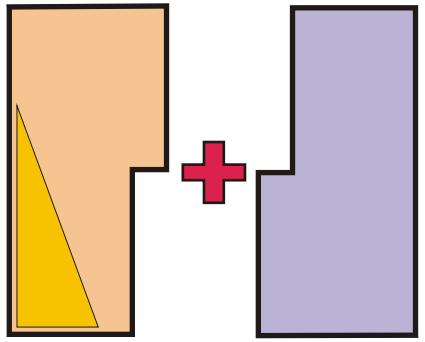
Type II - Double Occupancy

Type I

Double Occupancy

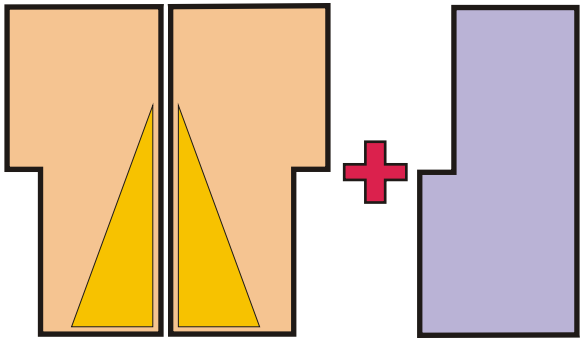
Built area - 3.0 x 4.5m
Modules - 3 No.s
Unbuilt area - Verandah

7.3.4 Arrangement of Modules



Room Module **Toilet Module**

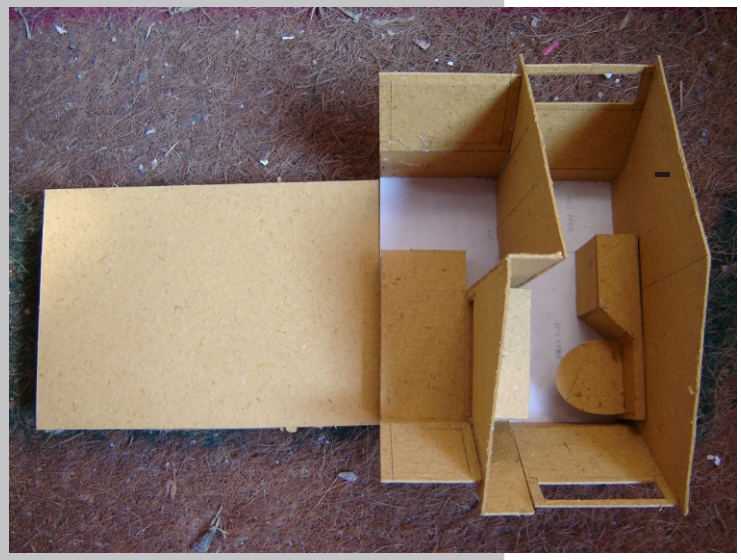
The room and toilet module arranged to function as a single occupancy hut



Room Module (RM) **Room Module (RM')** **Toilet Module (TM)**

The room module is mirrored to accommodate a king size bed for double occupancy.

7.3 Circulation & Planning



Type I - Single Occupancy

Type I

Single Occupancy

Built area - 3.0 x 3.0m
Modules - 2 No.s
Unbuilt area - Verandah

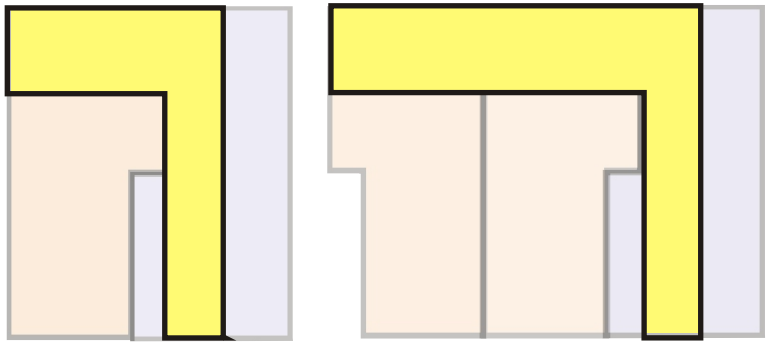
Type II - Double Occupancy

Type I

Double Occupancy

Built area - 3.0 x 4.5m
Modules - 3 No.s
Unbuilt area - Verandah

7.3.5 Circulation

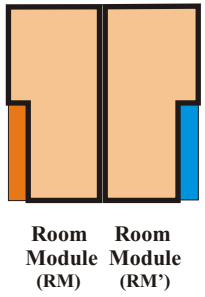


Type I **Type II**

A linear circulation Spine is maintained for an efficient layout.

7.3.6 Economy

The design attempts to bring down the cost of the product at multiple levels



Planning is such that a niche for seating in Module RM is used as a storage space in Module RM'.

Each module is made of building elements which is again modular and repetitive in nature. The same mould can be used for manufacture of various parts

FRP has been restricted to main structural built environment which can be repeatedly stored over the years

7.4 Design Attributes

Semi- open deck

The Middle band of FRP

Bamboo stilt supporting wooden deck

7.4.1 View to sea

An extended roof on the bamboo deck gives rise to a semi-open verandah which can be used for relaxing and watching the sea.

A large opening on the front facade ensure the view of the sea from the interior. It is positioned in such a way that the sea can be seen lying on the bed.

The front facade integrates along with its structure an inbuilt seating for the verandah. Apart form this the deck can be extended to provide space for beach lounges under shade.

7.4.2 Concern for present system of construction

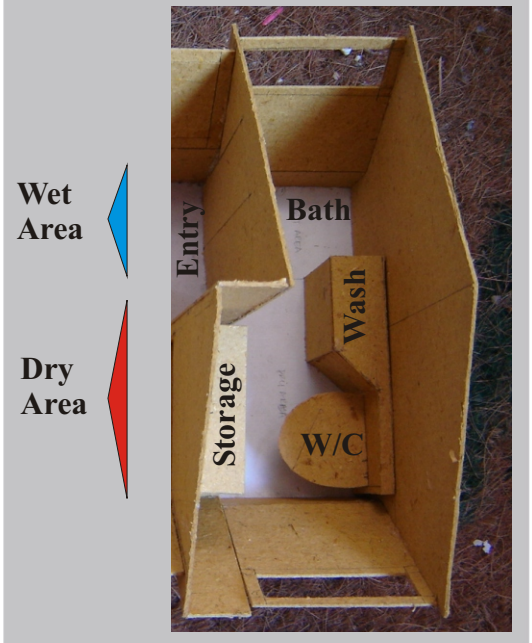
The present situation involves the yearly construction of coco-huts in bamboo and coconut leaves with wooden flooring. For this local masons are employed every year who are specialized in the construction of these huts and for whom this is a livelihood

The design envisions to develop itself in such a way that it **sustains what is present today** as well.

FRP elements are restricted to the middle band of construction which involves the major spine of design. This is divided into parts in such a way that they can be stored away easily. The deck is made of wood on bamboo stilts as per traditional method of construction. The roof is again a thatched roof where the walls have been provided with details to accommodate bamboo rafters.

This design thereby ensures the **participation of the local masons in the assembly** of the structure as well. The annual construction cost of the beach shack owners is reduced drastically. FRP is a very durable material on coast and can hence be repeatedly used for many years together.

Ventilation band above openings



7.4.3 Openings

The openings have been designed similarly on repetitive wall components so that their positioning aids the manufacture of each component as well.

Apart from the large window on the front facade and door for toilet all the other openings have hinged doors which can be pushed and hinged.

The position of the window on the tilted wall have been offset so that the walls bend themselves to form the overhang required

7.4.4 Ventilation

A continuous ribbon of ventilation has been provided in the space between the roof and the walls to ensure ventilation even if all the windows and doors are closed. Adequate detailing can be provided for preventing mosquitos from entering the huts through this gap

7.4.5 Security

A clear demarcation of the secure zone from the open & semi-open, public & semi-public areas have been done. The toilet module is designed for security so that all the other modules attached to it can be left open as per convenience when the residents push off to take a bath in the sea. Storage cabinets for books and similar luggage has been provided in the main living.

7.4.6 Toilet

The toilet is the closed area of the hut which can be locked and kept secure. For this a storage facility has been provided in the form of a cabinet.

The wc, bath and wash basin have been so arranged that the pipe lines can be drawn from the rear wall in a linear simple pattern

The shower is placed at the entrance because the resident would want to come back and be clean from sea water before they enter into the comparatively dry area of the toilet.

7.5 Evaluation of Design

The design was evaluated under the following heads

A. Based on viewpoint of tourist

B. Based on viewpoint of manufacturer

C. Based on viewpoint of Beach Shack Owner

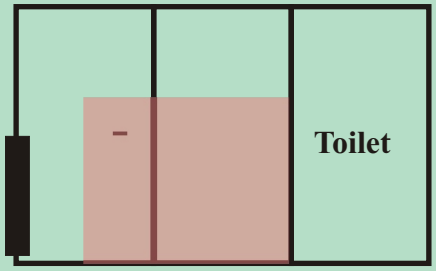
View from front

N0.	Criteria	Points (0-9)
1.	View to the Sea	5
2.	Sea Breeze with in the hut	5
3.	Semi open verandah	8
4.	Orientation of the bed	3
5.	Sand accumulation on floor	7
6.	Security of valuables	8
7.	Storage for clothes	7
8.	Toilet (Planning & Circulation)	7
9.	Ease of cleaning &maintaining	6
10.	Tactile sense	4
11.	Visual Image of Interior	6
12.	Form (Bi-cultural Identity)	7
13.	Ease of Manufacture	8
14.	Modularity	8
15.	Number of Joints	4
16.	Structural Strength	4
17.	Cues for integrating furniture	3
18.	Ease of assembly / dismantle	4
19.	Storage of module after dismantling	6
20.	All huts when arranged in a shack	7

7.6 Refinement of Design

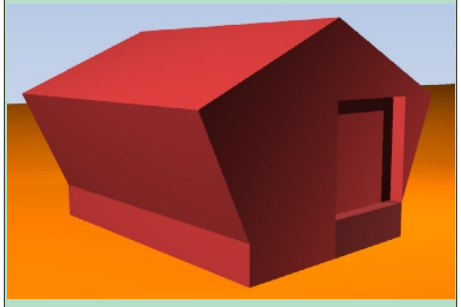
Based on the evaluation table the design was refined to **three different options**

Option 01



Main entrance

Plan (3m x 4.5m)

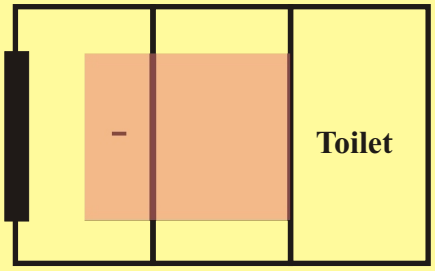


Salient features

Integrated furniture was replaced with cues for wooden furniture

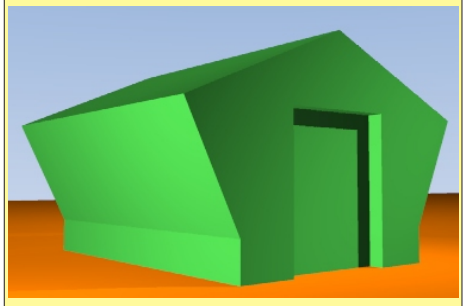
Joints were reduced as compared to previous model. Hence had better structural strength

Option 02



Main entrance

Plan (3m x 4.5m)



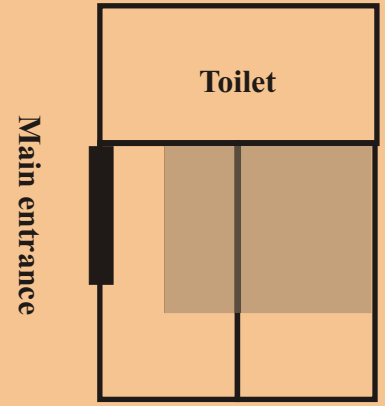
Salient features

Bed was positioned at center for better view of sea and interiors

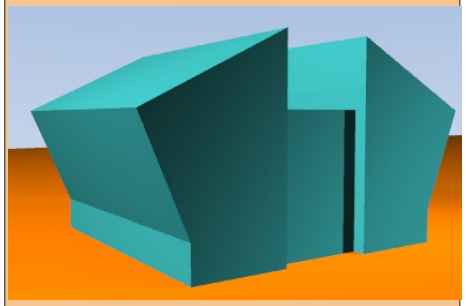
The main door is centrally locate and the form is more or less symmetrical

The main deck has longer seats on either side

Option 03



Plan (3m x 4.5m)



Salient features

Toilet can be accessed as soon as you enter

Though the module has achieved a good developed the design rates low for modularity anf view to the sea from interiors

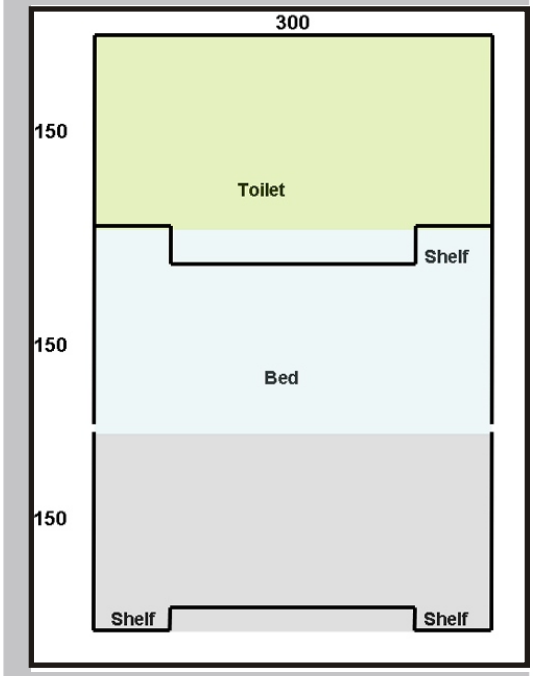
Evaluation of options	Option 01	Option 02	Option 03
1. View to the Sea	5	8	6
2. Sea Breeze with in the hut	5	8	8
3. Semi open verandah	8	8	8
4. Orientation of the bed	3	8	8
5. Sand accumulation on floor	7	5	7
6. Security of valuables	8	8	8
7. Storage for clothes	7	8	8
8. Toilet	7	7	5
9. Ease of cleaning	6	6	6
10. Tactile sense	6	6	6
11. Visual Image of Interior	6	8	8
12. Form (Bi-cultural Identity)	7	8	3
13. Ease of Manufacture	8	8	5
14. Modularity	8	8	3
15. Number of Joints	8	7	7
16. Structural Strength	4	7	7
17. Cues for integrating furniture	7	7	7
18. Ease of assembly / dismantle	4	7	5
19. Storage of module	6	5	5
20. All huts arranged in a shack	7	8	5
Total	127	145	125

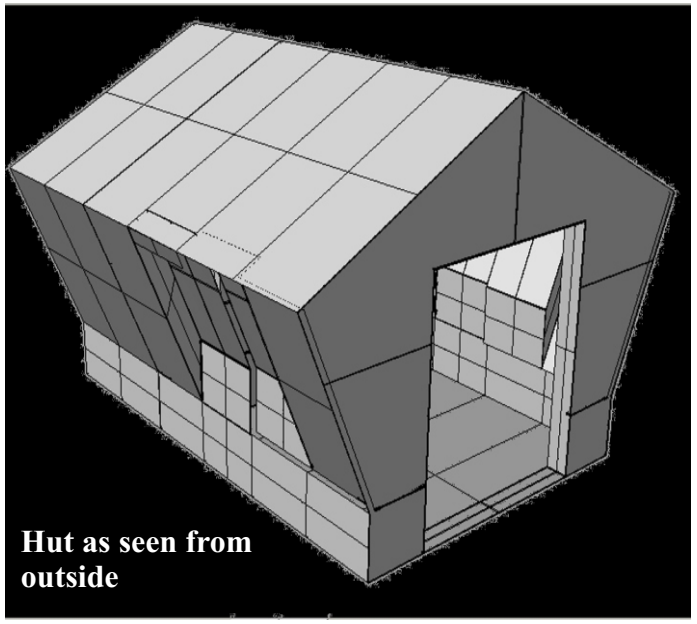
7.7 Detailing of Design

7.7.1 3D rendering

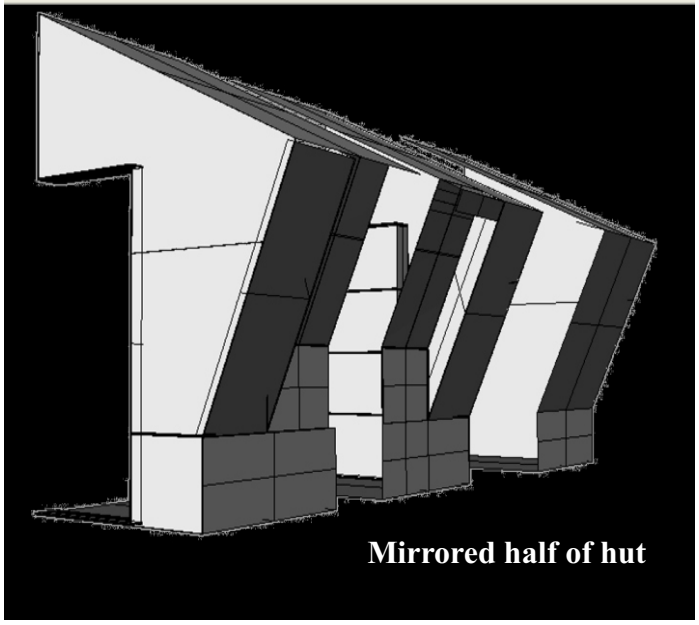
The Evaluation table revealed that option 2 had better possibilities if developed into the final design.

Option 2 has been detailed by quick rendering in software. This helped understand the space with in the structure. Six module pieces are joined together to form the whole. Mold has to be developed for two of them

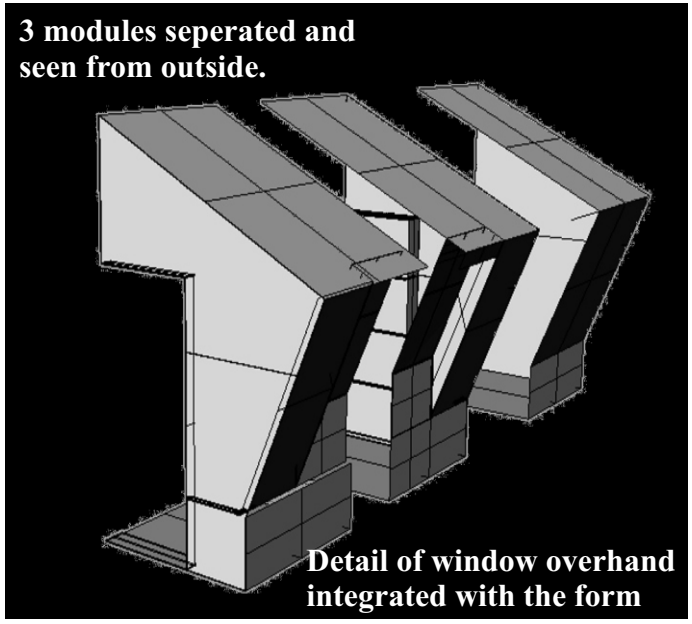




Hut as seen from outside

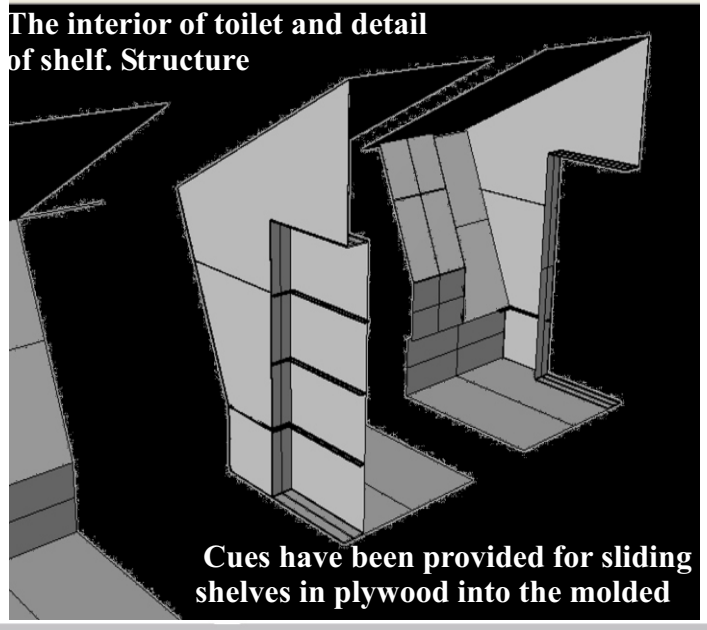


Mirrored half of hut



3 modules seperated and seen from outside.

Detail of window overhand integrated with the form



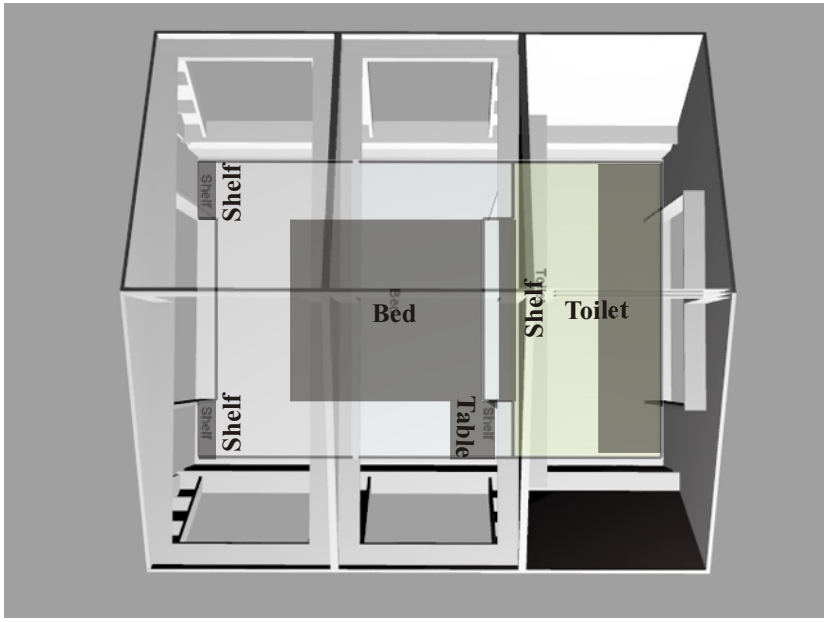
The interior of toilet and detail of shelf. Structure

Cues have been provided for sliding shelves in plywood into the molded

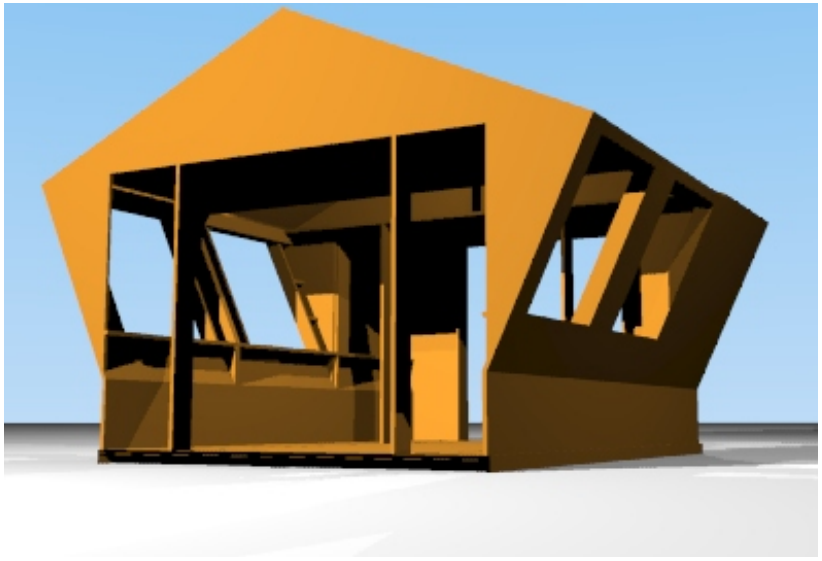
7.7 Detailing of Design

7.7.1 3D rendering

Once the skin of the design was decided more accurate 3D renders were made



The plan is more or less **symetrical** with a central bed. The window is also located centrally and provide better **view to the sea** from inside. The opening being centrally placed, the FRP skin is much stronger. The **skin has been bend** at various position and the niches have been exploited to locate shelves. This also adds to structural strength.

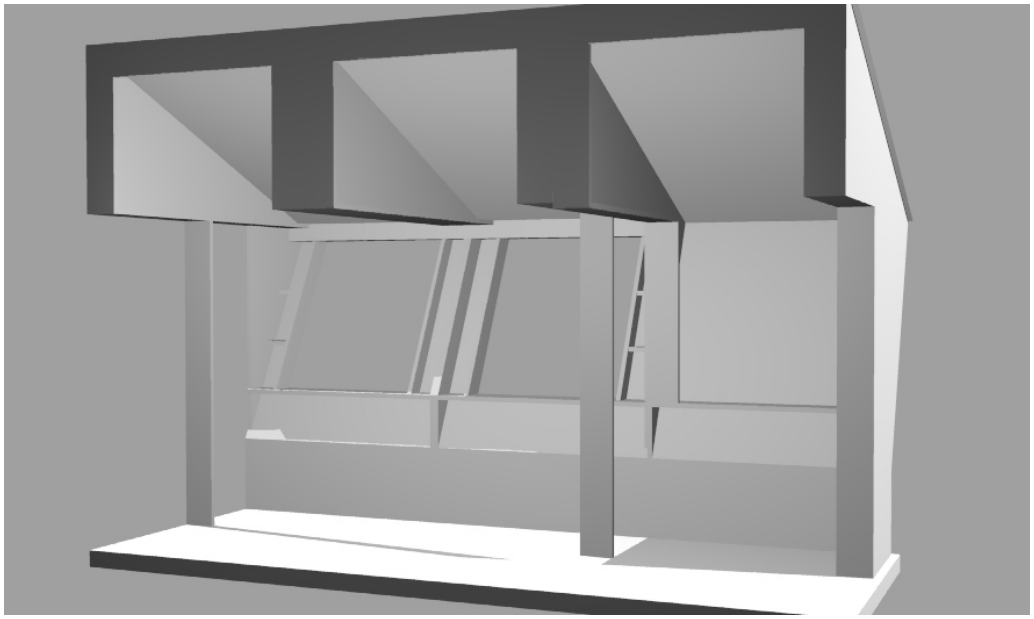


The structure centrally placed openings, with **broad frames**. The **slope** is steep and continues to spread to the wall of the hut. Windows have been detailed to provide **strength to the junction** where two modules join. Large openings have been provided for **maximum sea breeze** within and other openings on side walls for **cross ventilation.**

7.7 Detailing of Design

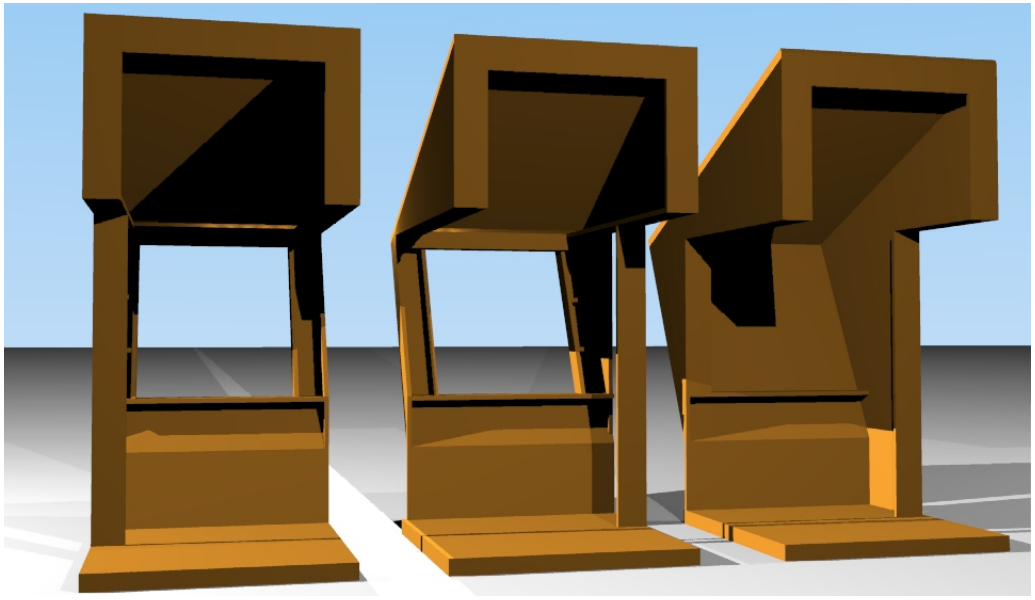
7.7.1 3D rendering

Once the skin of the design was decided more accurate 3D renders were made



The hut as seen from inside.

Grooves have been provided for **lighting fixtures.** The window frame has been further ribbed in the interior to act as **small display unit** for local manifests tourists would purchase from goa.

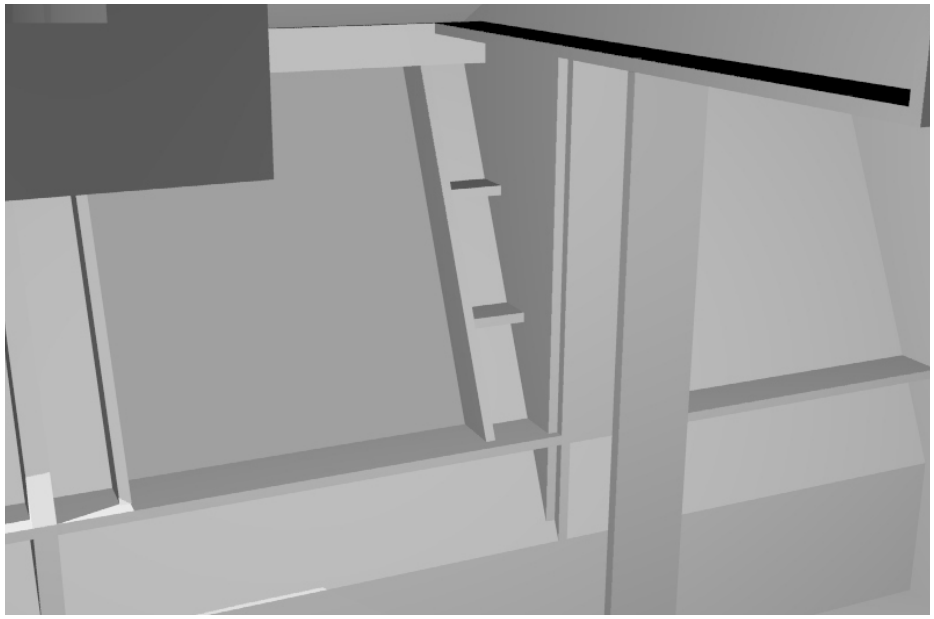


There are **two molds** used for double occupant. The third module is the mirror of the room module. Thus **six modules** make a hut. **Cues have been provided for furniture** like shelves where the plywood shelf can slide through channels provided.

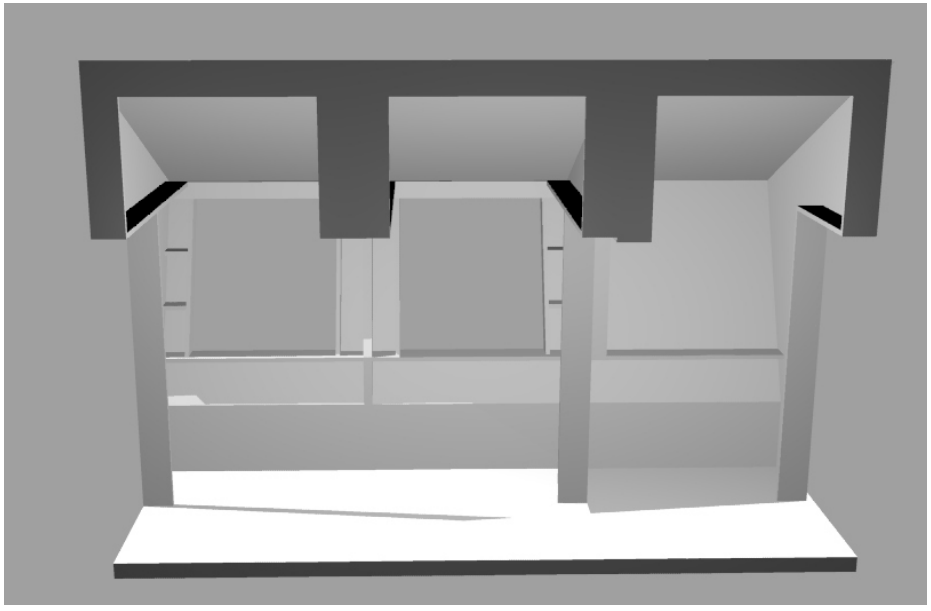
7.7 Detailing of Design

7.7.1 3D rendering

Once the skin of the design was decided more accurate 3D renders were made



The walls are 30mm in thickness as they are sandwiched panels of FRP with foam in between them. The details of the window is clear in this image.
The opening edges have Aluminium inserts on which windows and doors can be further joined. **Window Screens** can be selected to give a ethnic image to the interiors



The **cupboard in the toilet** is designed to occupy the dry area of the toilet . This acts as shelf for valuables as the toilet can be securely locked.
Two seperate shelves for clothes have been provided for both the tourists in the living unit.
Furnitures are made of ply which are more pleasing to the tactile sense.

BIBLIOGRAPHY

Bibliography

1. Pre Fab, adaptable, modular, dismountable, light, mobile architecture, 2002 @Loft Publications
2. Featherweights , Light mobile and Floating Architecture, Oliwer Herwig
3. Structural Design and Paper Board Cartons, Packing - Sha Company Ltd.
4. Goan Windows, Special Project, Muthu K, IDC, IIT Bombay
5. Construction in Bamboo
6. Production of Houses, Christopher Alexander
7. Modular Architecture, Le Corbusier
8. SMC/BMC: design for success! Europeon Alliance for SMC
9. Indian Anthropometric Dimensions, Debkumar Chakrabarthy, Ph.D
10. Presentatoin on Bi-cultural Identity of Products by Prof. Athvankar